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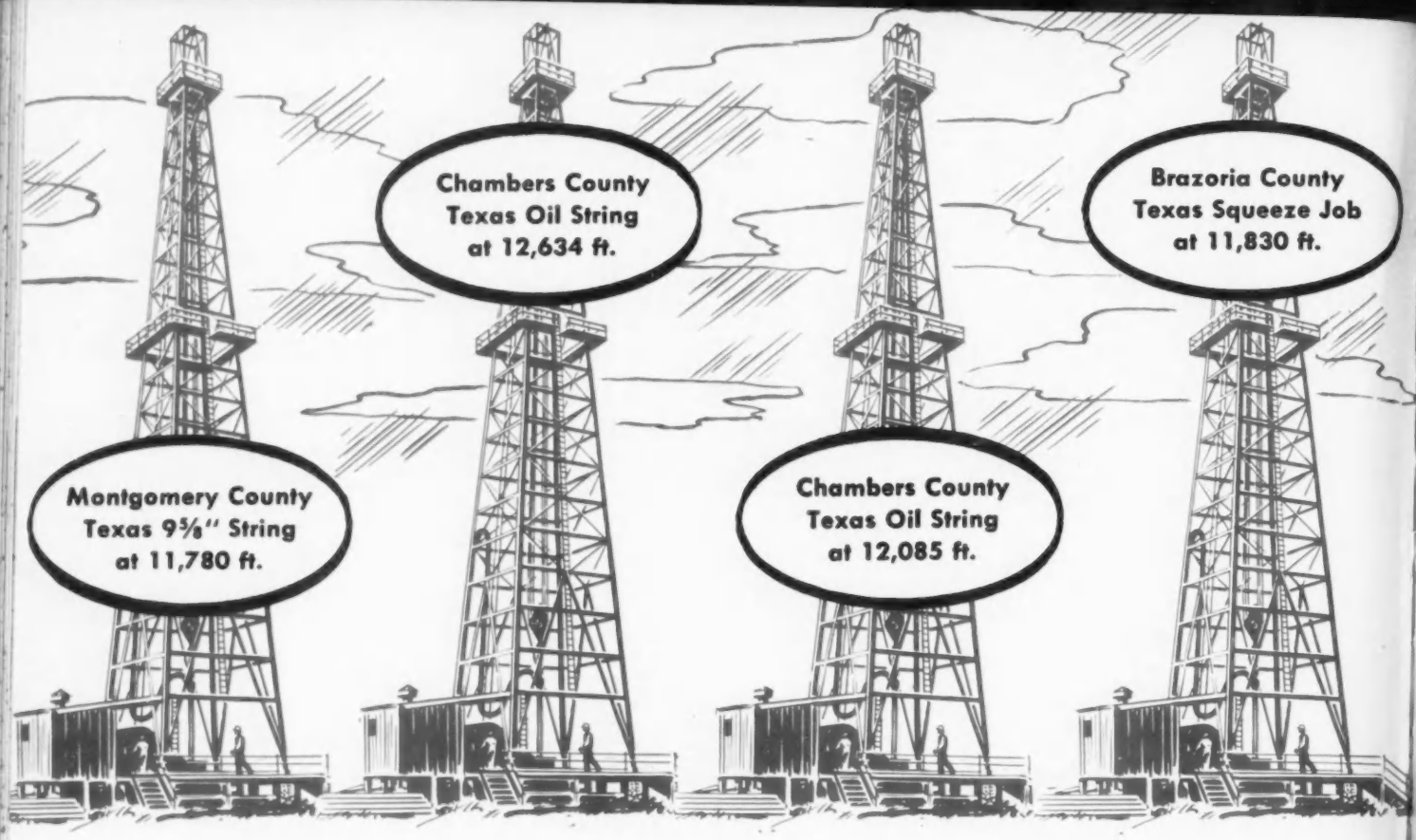

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Volume 145, No. 6 November, 1957

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WORLD OIL

Established 1916 as The OIL WEEKLY

a quick look at WORLD OIL this month

BUSY OIL MEN: To help you put first things first, scan these time-saving digests on this and the following pages, checking ☑ those you want to read first.

We Hope It Will Help

THE 86TH CONGRESS will be a momentous session for natural gas producers. The final decision on the Harris-O'Hara Bill will be made, and therein lie two important questions:

What will happen to the natural gas industry if the bill is not passed?

What effect will it have on the individual consumer?

Gulf Publishing Company has spent several months checking every available source to find the answers to these questions. The results of our efforts are contained in the eight-page natural gas booklet included with this issue.

As you will see, the booklet has been prepared for distribution to the individual consumer. It is written in language the consumer will readily understand, with the object in mind that he may be prompted to help natural gas producers in their legislative efforts.

After you have finished reading the booklet, you will be doing your industry a service by passing it on to a friend or neighbor.

☐ **The petroleum industry of the Free World** is expected to expand its capital expenditures by about 6 percent per year during the coming 10 years. The spending outside the U. S. probably will increase at a higher rate than that in the U. S. The continuing expansion of annual spending for new facilities will be required because of the anticipated further growth in demand for petroleum. Free World demand will increase about 7 percent per year, with U. S. consumption rising 4 percent and that outside the U. S. climbing 9 percent per year. **Capital Spending by World Oil Industry Due to Climb** ..... **Page 50**

Continued in Column 2, Page 4

Geophysical Advances

☐ **Seismic data processing** represents an important new tool for finding petroleum. It has evolved in recent years from the pioneering use of magnetic recording. The magnetic recording made possible the storage of seismic information in fully reproducible form. It was necessary for the geophysical exploration industry to have the right equipment and to produce processed data for some time before the full potentialities of data processing could become evident. By making available for study and interpretation much seismic information that previously was not preserved, modern seismic data processing promises to help greatly in finding petroleum. Through it can be found oil accumulations governed by stratigraphic traps, lithologic changes, faulting, and changes in section thickness. See **Page 75. Seismic Data Processing Is a New Exploration Tool**... **K. E. Burg**

☐ **The acoustic logging tool** or continuous velocity logger provides an advanced method of obtaining reliable and detailed velocity information for the seismologist in his work of interpretation. It also has proved to be an excellent correlation tool for the geologist. Furthermore, it has become an increasingly effective tool for the petroleum engineer or geologist studying formation porosities and fluid saturation problems. Velocity information may confirm or disprove an interpretation of seismic data. It may identify the zone of reflection energy. It may tie geology to seismic reflections. For a better understanding of continuous velocity logging, how it is done, and what it reveals, turn to **Page 78. Velocity Surveys Aid in Seismic Interpretation**.....**C. H. Thurber**

☐ **A new plotting machine,** primarily developed to facilitate the handling of the large number of seismograms produced by offshore exploration programs, is described in the story beginning on **Page 83. A New Seismic Dip Plotting Machine**....**J. A. Westphal**

☐ **A newly developed electrical recorder** has proved its usefulness in reproduction of magnetically recorded seismic data. Use of magnetic recording in seismic exploration has posed the problem of displaying the magnetically recorded data in useful form. The data have to be converted to visual records for checking in the field and for study in the interpretation office. Multitrace seismic records are made through the use of electrically sensitive paper. The record is immediately available for use without any type of processing. Turn to **Page 85. Visual Records Made From Magnetically Recorded Data**.....**C. F. Hadley and J. D. Eisler**

CURRENT OUTLOOK continued from Page 3

☐ **A vigorous leasing campaign,** reminiscent of early gold rush days, has occurred in Alaska in recent months. The activity has followed an apparently important oil discovery on Kenai Peninsula, 40 miles southwest of Anchorage. The discovery well was drilled by Richfield Oil Corporation and associates. It flowed high gravity oil from well perforations at 11,150-11,215 feet. See **Page 52. Leasing Active Following Oil Discovery in Alaska**.....**Gilbert M. Wilson**

☐ **Here is an excellent yardstick** to use in evaluating the success of your company's public relations program. This check list of 50 questions will be of particular help to executives, foremen and supervisors. Pass copies around in your company as another reminder of the importance of public relations in your operation. **See Page 53. Are You "Aware" of the Public?** .....**Paul Lockwood**

☐ **In this busy world,** health isn't given much consideration—until a person has lost it. Whether you are in the business or operational end of the oil industry, you will benefit from these 10 excellent ways to a longer, more enjoyable life. **See Page 55. How To Live Longer and Like It!**.....**Ernest W. Fair**

☐ **Want to increase your total of "safe" employes?** You can, by making better use of application forms to weed out the "accident prone" and "accident repeater". For details on this excellent safety plan, plus a timely description of the personnel man's role in safety, turn to **Page 58. Where Safety Begins**.. **G. H. Thompson**

DRILLING ARTICLES

☐ **Recent deep drilling resulting in high bottom hole temperatures** has imposed a serious limitation on deep well operations. A drilling fluid satisfactory for hot holes should be of the inhibited type, have a neutral pH, require no pH control, have a controllable electrical resistivity and utilize additives which are heat stable and non-reactive. A neutral non-ionic surfactant that has been developed recently by the Magnolia Petroleum Company approaches these ideal conditions. For further information on these fluids, see **Page 101. Calcium Surfactant Drilling Fluids**..**R. F. Burdyn and L. D. Wiener**

☐ **Substantial savings are being realized** by Imperial Oil Limited, which is using a low cost, small horsepower engine with a centrifugal pump as a low-pressure mixing system for mud. Besides the economy, this system offers the advantages of safety as well as being able to circulate the kelly while in the rat hole,

WORLD OIL, published every month except semi-monthly in February and August. Entered as THE OIL WEEKLY as second class mail matter December 23, 1916, at post office at Houston, Texas, under the act of March 3, 1879.

super-charge the main mud pump, agitate the pits, and mix the mud. Turn to **Page 110** for the type of savings that can be effected. **Low Pressure-High Volume Mud Mixing Systems. . L. W. Woodridge and Stan P. MacKay**

☐ **Many variables are inherent** in the rotary hydraulic system. The thorough understanding of these variables and how to control them for the successful use of conventional and particularly jet bit drilling are discussed beginning on **Page 112. Keys to Successful Competitive Drilling (Part 5C) . . . Roy A. Bobo and Robert S. Hoch**

☐ **Will turbodrilling take its place** in the oil industry? The increased possibility of this is advanced through the theoretical comparison of turbo and conventional drilling methods. Turn to **Page 119** for the first of a two-part article discussing what effect turbodrilling will have on present methods and in what instances it might economically replace these methods. **The Theoretical Approach to Turbodrilling (Part 1) . . . W. Tiraspolsky**

☐ **Drilling in water with the ease of land drilling** is the result of a patented technique used by the CUSS group, Continental Oil Company, Union Oil Company, Shell Oil Company and The Superior Oil Company. Drilling bits and guide cables are suspended from a seagoing vessel as a base of operations. Apparently, there is no limit to the water depth for drilling operations. For a thorough description of the practice, turn to **Page 130. Offshore Drilling Goes Deeper.**

PRODUCTION ARTICLES

☐ **A complete explanation** is given of the practical application of a lease metering and automatic custody transfer unit. The explanation includes the reasons for the choice of meters, detail of the design, and the operation of the unit. The metering system and individual well control are presented. See **Page 133. How "Fail-Safe" LACT Unit Works . . . Frank W. Beach**

☐ **Determining damage to a zone surrounding the well bore** can be made easier by using the nomograph on **Page 138.** With a basic amount of data, the approximate damage ratio for this zone of reduced permeability can be determined quickly. **Damage Ratio Determined by Drillstem Test Data . . . . . Dr. H. K. van Poollen**

☐ **Gyp deposition,** one of the toughest problems to the producer, has given ground to a new technique. A polyphosphate sequestering agent mixed with the ingredients of a conventional fracturing treatment has resulted in decreased gyp deposition within the formation and on well equipment and has also resulted in marked increases in production. Turn to **Page 140** for more information on this technique. **What Can Be Done About Gyp Deposition? . . . . . Anthony Gibbon**

☐ **Tracer studies with radioactive hydrogen** is a valuable research tool being used to obtain data on reservoir flow characteristics and patterns of fluid migration in oil and gas reservoirs. Time required for the "tagged" material to pass from the injection to the producing point shows whether the formation is homogeneous or heterogeneous. Turn to **Page 144. Tritium—Newest Tool for Determining Reservoir Flow Characteristics . . . . . Robert E. Fearon**

☐ **Use of capacitance-sensitive instruments** appears to be the solution in controlling BS&W content in crude oil delivered to automatic custody transfer facilities. The monitor described in the article beginning on **Page 151** continuously inspects the BS&W content of crude oil delivered from the separator or treating equipment to the tank. When crude exceeds BS&W specifications, this instrument actuates control valves and re-routes fluid to the wet oil storage or treating equipment. **Oil Field 'Watchman' Checks BS&W Content. . . . . Howard J. EnDean**

☐ **Greatest ultimate oil recoveries** from combination drive fields can be promoted through the mechanisms of *voluntary unitization* and *enlightened proration.* The impact of such programs on oil conservation is discussed on **Page 130** in the third and concluding part of **Universal Theory of Oil Reservoir Engineering. . . . . Dr. S. J. Pirson**

INTERNATIONAL ARTICLES

☐ **The longest big-inch pipe line** ever laid in Venezuela was scheduled to begin operation early in November. A joint operation of Socony Mobil Oil Company de Venezuela and Sinclair Oil and Refining Company, the new $26 million, 212-mile, 20-inch crude line will deliver Barinas Basin crude to the Caribbean shore at Puerto Cabello. The new line represents the first outlet for crude sources developed and previously capped in Venezuela's most isolated oil province. More vigorous exploration is expected due to the line's completion, which in turn may result in expanded pipe line construction activity in the Venezuelan interior. See **Page 171. Big-Inch Crude Pipe Line Frees Barinas Basin Oil. . . . . H. T. Brundage**

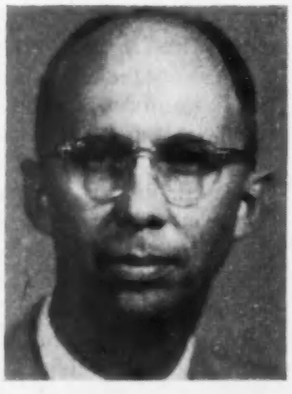
☐ **Creole Petroleum Corporation's** Well 20 in Lake Maracaibo, Venezuela, blew out of control during workover operations. After initial efforts to control the well failed, it blossomed into flame. For a photographic coverage of this spectacular fire, see . . . . **Photos Capture Fury of Blazing Well . . . . . Page 174**

☐ **A new trend in oil field camps** is developing in Venezuela where Creole Petroleum Corporation is taking steps to replace the old paternalistic camp. How? By developing neighborhood communities with privately owned homes, stores, public schools and hospitals. For an on-the-scene description of this trend, turn to **Page 176. Creole Undertaking Community Integration . . . . . Warren L. Baker**

William G. Dudley New Vice President of Gulf Publishing

William G. Dudley has been elected a vice president of Gulf Publishing Company. For the past three years he has worked in various capacities in the Advertising department, including market research and ad sales. Immediately prior to this new appointment, he was advertising sales manager for PETROLEUM REFINER and REFINERY CATALOG.

Dudley was the youngest navigator in the U. S. Air Force's Pacific operations during World War II. After graduation from the Rice Institute in 1949 with a B. S. in chemical engineering and an M. S. in chemistry in 1951 from The University of Texas, he worked with the research staff of Dow Chemical Company, Freeport, Texas. He was a group leader when he resigned to join the editorial staff of PETROLEUM REFINER, another Gulf publication, in 1951.



Donald E. Kliewer Assumes Duties as WORLD OIL Editor

Donald E. Kliewer has been named editor of WORLD OIL. As international editor with WORLD OIL for six years, he has supervised six editions of the informative International Outlook Issue, as well as handling the regular International section.

Kliewer was telegraph editor of the Paris, Texas, *News* and *Galveston News and Tribune* before entering the Army in 1942. He rejoined the *Paris News* as a reporter in 1946; moved to managing editor of the *Hillsboro Mirror;* the city editor and, later, news editor of the *Galveston News.*

He joined *The Houston Post* in 1948 as a copy reader and was later make-up editor. He relinquished his position with the *Post* in 1948 as assistant news editor to become international editor of WORLD OIL.

Kliewer graduated from The University of Texas in 1941 with a Bachelor of Journalism degree.

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WORLD OIL and THE COMPOSITE CATALOG for the drilling-producing industry.

PETROLEUM REFINER and THE REFINERY CATALOG for the refining-natural gasoline-petrochemical industry.

PIPE LINE INDUSTRY and THE PIPE LINE COMPOSITE CATALOG for the oil and gas pipe line industry.

Indexed by Industrial Arts Index and Engineering Index

LOOKING AHEAD . . .

November Quotas in Texas Close to Needs . . . Allowable crude production in Texas in November, as ordered by the Texas Railroad Commission, is fairly well in line with indicated demand. The commission ordered 12 producing days in November, the same as in October. November has only 30 days, compared with 31 in October. The calendar day allowable production in November, an average of 2,998,927 barrels per day, therefore will be 58,788 barrels above the mid-October allowable.

The U. S. Bureau of Mines had estimated that the demand for Texas crude would be up 80,000 barrels per day in November. In their nominations at the Railroad Commission's hearing before issuance of the November order, purchasers of Texas crude had indicated requirements of 16,867 barrels per day more in November than they had wanted for October.

Only one company, Sinclair Oil Corporation, wanted as much as 13 days' production from Texas fields in November. The majority wanted 12 days, as finally ordered by the Railroad Commission.

Humble Oil & Refining Company, largest buyer of Texas crude, along with Sun Oil Company and the Atlantic Refining Company, recommended only 11 producing days. Humble foresaw an accumulation of 800,000 barrels of Texas crude in its storage in November for every producing day allowed above the 11 days it recommended. Humble explained that its sales of crude to several Texas Gulf Coast refineries had decreased sharply, and that the plants would continue curtailment of refinery runs through December.

Gulf Oil Corporation recommended only 10 producing days in Texas in November, so that it could take the full allowable production from wells to which it was connected. Gulf in October was buying only 88 percent of the allowables. The wells from which it was taking oil were being produced on the basis of 10 producing days for the month.

Drilling Is Retarded by Low Allowables . . . The continuing pinch on crude production, forcing allowable production per well lower, undoubtedly is one of the principal causes of this year's curtailment of drilling in the U. S. Many independent operators depend on sustained output of their wells to meet their scheduled financial obligations. They have trouble borrowing or otherwise obtaining enough funds for drilling new wells, when there is danger that income from the wells will be reduced by low allowables.

Other things which have retarded drilling have included particularly the tight money situation and the diversion of substantial oil company funds to the purchase of concessions in Venezuela and other foreign countries.

The conditions which have caused curtailment of drilling have not yet materially changed. Some drilling contractors and others therefore do not look for an early increase in drilling. One contractor said that in the past, drilling has been cyclical. He considered it possible that it might be several years from now before the U. S. would exceed the 58,000 wells drilled in 1956. For 1957 WORLD OIL has estimated 55,670 well completions. (WORLD OIL, August 15, 1957, Page 122.)

Color Photography from Air Aids in Exploration . . . Aerial color photography rapidly is shaping up as a new, rapid geologic reconnaissance tool. It greatly extends the range of airborne geophysical surveying. The past two years have seen it used on an increasingly larger scale. Companies find it extremely valuable in making a rapid, high-quality reconnaissance of a new area.

Although color is about 30 percent higher in cost due to higher film cost, more precise and exacting exposure and processing, the over-all cost is but a fraction of that required to send geological parties into the field.

Good Wells Make Good News

November, 1957

WATER is an economical, effective fracturing fluid. It may be gelled or not. Acid may be added for treating acid-soluble formations. A wide variety of addition agents can also be added to combat emulsions, silicate swelling and other formation peculiarities. Here are some recent treatments that illustrate how Dowell engineers use water for successful fracturing under various conditions.

- **Grant County, Western Kansas** (Old Gas Well): This well was completed in the Hugoton series in 1949, and brought-in with 14,000 gallons Dowell X Acid. When deliverability declined to 423 mcfd, the operators decided to plug back into the Winfield zone and fracture the upper zones with Riverfrac*. Dowell performed the service using 80,000 gallons fresh water—*without sand.* Injection rate down casing *averaged 100 bpm. Deliverability after treatment was 1200 mcfd.*

- **Ector County, West Texas** (New Well): This well was completed in tight Clear Fork dolomite with perforations from 5696 to 5736 feet (two per foot). When well would not produce without stimulation, Dowell recommended Riverfrac with acid added. Treatment was performed using 20,000 gallons water with 5,000 gallons concentrated acid added, and 25,000 pounds sand. This was followed by a 20,000 gallon water flush, with de-emulsifying agent added. Injection was down casing at 76 bpm at 1800 psi maximum. *After treatment, well tested 360 bopd flowing. This was about three times the production of similar wells in this pay that had been fractured with oil-base or oil-and-acid fluids.*

- **Alberta, Canada** (Old Gas Well): A well completed in the Basal Quartz sand of the Morinville area had gone to water. When it was plugged back to 4,308 feet, water was shut-off, but gas production was negligible. Dowell was called to fracture with Waterfrac—using 2,100 gallons gelled water and 4,000 pounds sand, preceded by a 250-gallon spearhead of Mud Acid. *After treatment, well tested 30.5 mmcfd open flow and delivered 3.5 mmcfd to pipe line—with no water.*

- **Chase County, Eastern Kansas** (New Well): Open hole completion, 2,278 to 2,287 feet, in the Bartlesville sand near the edge of a waterflood project. Initial test revealed only show of oil. For stimulation, operator selected Riverfrac, using 31,600 gallons fresh water and 25,000 pounds sand. Well was treated down casing at 24½ bpm average injection rate. *60 days later, production had stabilized at 70 bopd.*

Part of the secret of success in using water for fracturing, is the experience of the service company you have perform the service. That's why it is important to specify Dowell. For information on the use of water for fracturing—or for service, call any of the 165 Dowell offices in the United States and Canada; in Venezuela, contact United Oilwell Service. Or write Dowell Incorporated, Tulsa 1, Oklahoma.

Services for the oil industry

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The Natural Gas Bill

. . . The Producer And The Consumer

Natural gas producers will never forget June 7, 1954. That was their judgment day. That was the day the Supreme Court, by a split 5 to 3 decision, said in effect:

"You are a public utility. As such, you can no longer compete for a fair market price. The Federal Power Commission now has authority to control your prices at the wellhead."

Some time after the 86th Congress convenes in January, the Supreme Court ruling will be at least partly nullified—if the Harris-O'Hara Bill is passed. The natural gas producers' second judgment will come when that decision is reached.

The Harris-O'Hara Bill is far from providing the freedom producers need. It will still give the FPC authority to establish market prices of gas at the point of production. However, it will relieve the producers from stifling price controls based on cost-plus which had previously been considered. It is a step in the right direction.

With so much at stake, it stands to reason that each oil and gas employe should exert every effort within the bounds of discretion to see that corrective legislation is passed. The job ahead is aptly described by L. F. McCollum, president of the Continental Oil Company:

"Our job is to let Mr. and Mrs. America know what federal regulation of field gas prices will mean to them—not in technical or legal terms, but in terms of their own everyday experiences.

". . . When we talk to the American public—that means those who are now gas consumers and those others who would like to be—we must *accentuate the position of the consumers,* lest we lose their interest. We must give them the facts as to what will be the real effects on their lives of federal control over field prices of natural gas.

"We must actively enlist public support for legislation that will assure the continuation of the essential services rendered to the public by the vast natural gas industry."

In keeping with Mr. McCollum's thoughts, The Gulf Publishing Company has prepared a special eight-page supplement, a copy of which is included in this issue. It has been prepared as an aid to the industry—to provide you with all the facts concerning the Harris-O'Hara Bill in terms the individual consumer will understand. We sincerely hope it will be of help to you.

As a part of its contribution, The Gulf Publishing Company is sending a copy to each senator and congressman.

If every employe in the oil and gas industry will pass one copy of this supplement on to a friend or neighbor, the industry can win many new friends. Some of your friends may become interested enough to let their senators and congressmen know how they feel about keeping industry free of federal control.

To make such an effort possible, The Gulf Publishing Company is offering reprints of the supplement to the oil and gas industry for the cost of printing. The prices are: Under 100 reprints, 10 cents each; 100 to 1000, 7½ cents each; 1000 to 10,000, 5 cents; 10,000 to 20,000, 4½ cents; over 20,000, 4 cents.

You may place orders by writing to The Gulf Publishing Company, Post Office Box 2608, Houston 1, Texas.

Here is *your* chance to help *your* industry. Let's all *"actively enlist public support for legislation that will assure the continuation of the essential services rendered to the public by the natural gas industry."*

If everyone will pitch in and do his part, there is a chance the next judgment day will be a happy one.

Capital Spending by World Oil Industry Due to Climb

Free World expenditures are expected to increase about 6 percent per year. Expansion of facilities will be needed to keep abreast of anticipated 7 percent annual growth in demand for petroleum.

CAPITAL EXPENDITURES by the petroleum industry of the Free World will regularly increase about 6 percent per year during the next 10 years, although the increase will temporarily drop to about 1.2 percent in 1958. Spending in the U. S. will increase around 5 percent annually, and that in other free countries about 8 percent per year.

The steady increase in spending is expected because of the anticipated continuing strong growth in demand for petroleum The Free World demand is expected to rise about 7 percent per year, with U. S. consumption increasing about 4 percent annually and demand in other free countries climbing about 9 percent per year. (Table 2.)

These figures are estimates of Frederick G. Coqueron, of the petroleum department of the Chase Manhattan Bank, New York. They are embodied in a comprehensive, detailed 10 year forecast of capital expenditures. The figures on spending are based, in turn, on the same bank's 10 year forecast of Free World petroleum supply and demand, in the pamphlet, "Future Growth of the World Petroleum Industry."

Spending in 1958. Capital expenditures of the Free World petroleum industry will total about $10,350,000,000 in 1958. That will be an increase of 1.2 percent over the $10,225,000,000 being spent in 1957.

The spending of 1957 represents an increase of 4.3 percent over the $9,800,000,000 spent in 1956. The latter figure was 18.9 percent over the $8,245,000,000 spent in 1955.

The indicated slowing down of the growth in spending in 1957 and 1958 involves foreign free countries more than the U. S. It reflects particularly the irregular spending rates for costly concessions in Venezuela. There was no awarding of Venezuelan concessions in 1955. But operators spent $310 million for Venezuelan concessions in 1956 and $375 million in 1957.

In 1958 less is expected to be spent for production in Free Foreign countries. Total spending in those countries in 1958 will be $3.7 billion, a decrease

TABLE 1

Estimated Capital Expenditures of the Free World Petroleum Industry in Years 1955-1966

(Source: Chase Manhattan Bank, New York)

MILLION DOLLARS

YEAR	Production Division	Refineries and Chemical Plants	Transportation and Marketing	Total	% Gain Over Previous Year
UNITED STATES					
1955	....	....	....	5,600	..
1956	4,475	825	750	6,050	8.0
1957	4,600	875	850	6,325	4.2
1958	4,850	900	900	6,650	5.1
Percent of Total	73.0	13.5	13.5	100.0	..
1959	5,100	1,000	950	7,050	6.0
1960	5,400	1,025	1,000	7,425	5.3
1961	5,675	1,050	1,100	7,825	5.3
1957-1961	25,625	4,850	4,800	35,275	..
1962	5,900	1,150	1,175	8,225	5.1
1963	6,125	1,200	1,250	8,575	4.2
1964	6,400	1,275	1,325	9,000	5.0
1965	6,625	1,325	1,450	9,400	4.4
1966	6,900	1,375	1,500	9,775	4.0
1962-1966	31,950	6,325	6,700	44,975	..
1957-1966	57,575	11,175	11,500	80,250	..
FREE FOREIGN					
1955	....	....	....	2,645	..
1956	*1,550	725	1,475	3,750	41.8
1957	*1,600	750	1,550	3,900	4.0
1958	1,300	775	1,625	3,700	—5.4
Percent of Total	35.1	21.0	43.9	100.0	..
1959	1,425	850	1,700	3,975	7.4
1960	1,550	900	1,800	4,250	6.9
1961	1,700	1,000	1,900	4,600	8.2
1957-1961	7,575	4,275	8,575	20,425	..
1962	1,825	1,100	2,025	4,950	7.6
1963	2,050	1,200	2,150	5,400	9.1
1964	2,225	1,300	2,300	5,825	7.9
1965	2,450	1,400	2,450	6,300	8.1
1966	2,725	1,500	2,625	6,850	8.7
1962-1966	11,275	6,500	11,550	29,325	..
1957-1966	18,850	10,775	20,125	49,750	..
FREE WORLD					
1955	....	....	....	8,245	..
1956	6,025	1,550	2,225	9,800	18.9
1957	6,200	1,625	2,400	10,225	4.3
1958	6,150	1,675	2,525	10,350	1.2
Percent of Total	59.4	16.2	24.4	100.0	..
1959	6,525	1,850	2,650	11,025	6.5
1960	6,950	1,925	2,800	11,675	5.9
1961	7,375	2,050	3,000	12,425	6.4
1957-1961	33,200	9,125	13,375	55,700	..
1962	7,725	2,250	3,200	13,175	6.0
1963	8,175	2,400	3,400	13,975	6.0
1964	8,625	2,575	3,625	14,825	6.1
1965	9,075	2,725	3,900	15,700	5.9
1966	9,625	2,875	4,125	16,625	5.9
1962-1966	43,225	12,825	18,250	74,300	..
1957-1966	76,425	21,950	31,625	130,000	..

*Free Foreign production expenditures include costs of Venezuelan concessions amounting to $310 million in 1956 and $375 million in 1957.

TABLE 2

Forecasts of Free World Petroleum Supply and Demand 5 Years and 10 Years in Future

Source: Chase Manhattan Bank pamphlet, "Future Growth of the World Petroleum Industry"

THOUSANDS OF BARRELS DAILY

YEAR	UNITED STATES		FREE FOREIGN		FREE WORLD	
	Amount	% Gain Over 1956	Amount	% Gain Over 1956	Amount	% Gain Over 1956
DEMAND						
1956	8,757	....	6,793	....	15,550	....
1961	11,200	27.9	9,825	44.6	21,025	35.2
1966	14,300	63.3	14,200	109.0	28,500	83.3
SUPPLY						
1956	7,939	....	7,640	....	15,579	....
1961	9,600	20.9	11,125	45.6	20,725	33.0
1966	11,000	38.6	17,000	122.5	28,000	79.7

of 5.4 percent from the $3.9 billion of 1957. The 1957 spending is up 4.0 percent over the $3.75 billion of 1956. The 1956 total was 42 percent above the $2,645,000,000 of 1955, which included no purchases of Venezuelan concessions.

Capital expenditures of the petroleum industry in the U. S. in 1958 are estimated at $6,650,000,000. That amount would be an increase of 5.1 percent over the $6,325,000,000 being spent in 1957. The 1957 spending will be 4.2 percent above the $6,050,000,000 of 1956. The 1956 figure was 8 percent over the $5.6 billion spent in 1955.

The Free World total capital expenditures of $10,350,000,000 in 1958 will include $6,150,000,000 or 59.4 percent for production facilities, $1,675,000,000 or 16.2 percent for refineries and chemical plants, and $2,525,000,000 or 24.4 percent for transportation, marketing, and other facilities.

U. S. and Foreign. The U. S. expenditures of $6,650,000,000 in 1958 will include $4,850,000,000 or 73 percent for production, $900 million or 13.5 percent for refineries and chemical plants, and $900 million or 13.5 percent for transportation, marketing and other items.

The Free Foreign expenditures of $3,700,000,000 estimated for 1958 will include $1.3 billion or 35.1 percent for production facilities, $775 million or 21 percent for refineries and chemical plants, and $1,625,000,000 or 43.9 percent for transportation, marketing and other properties.

Demand to Climb. Free World demand for petroleum is expected to increase about 7 percent per year during the next decade. From the 15,550,000 barrels daily of 1956 it is expected to expand to about 21,025,000 barrels daily in 1961, an increase of 35.2 percent. By 1966 the demand is forecast at 28.5 million barrels daily, or 83.3 percent above 1956. (See Table 2.)

The demand will increase more sharply outside the U. S. than in the U. S. Compared with 6,793,000 barrels daily in 1956, Free Foreign demand is estimated at 9,825,000 barrels daily in 1961, an increase of 44.6 percent in the five years or nearly 9 percent per year. By 1966 it will have more than doubled to 14,200,000 barrels daily, it is estimated.

In the U. S. the demand is expected to rise from 8,757,000 barrels daily in 1956 to 11,200,000 daily in 1961, a gain of 27.9 percent for the five years, or about 5½ percent per year. By 1966 the U. S. demand is estimated at 14,300,000 barrels daily, or 63.3 percent above 1956. In that year the demand outside the U. S. is expected to virtually equal the U. S. demand for the first time.

Foreign Supply to Jump. In meeting the Free World demand for petroleum, foreign fields will assume an increasingly important role. The total supply is expected to be stepped up directly in line with the increasing demand.

Free Foreign supply of 7,640,000 barrels daily in 1956 was somewhat less than the supply provided by the U. S. But the Free Foreign supply is expected to rise to 11,125,000 barrels daily in 1961, an increase of 45.6 percent in the five years or at the rate of about 9 percent per year, in line with the increase in Free Foreign consumption. By 1966 the Free Foreign supply is estimated at 17 million barrels daily, or more than double the 1956 rate. That amount would be substantially more than total Free World supply in 1956.

U. S. supply of petroleum is expected to increase from 7,939,000 barrels daily in 1956 to 9.6 million daily in 1961, a gain of 20.9 percent for the five years or over 4 percent per year, but a smaller increase than that for U. S. demand. By 1966 the U. S. supply is estimated at 11 million barrels daily, up 38.6 percent over 1956.

—The End

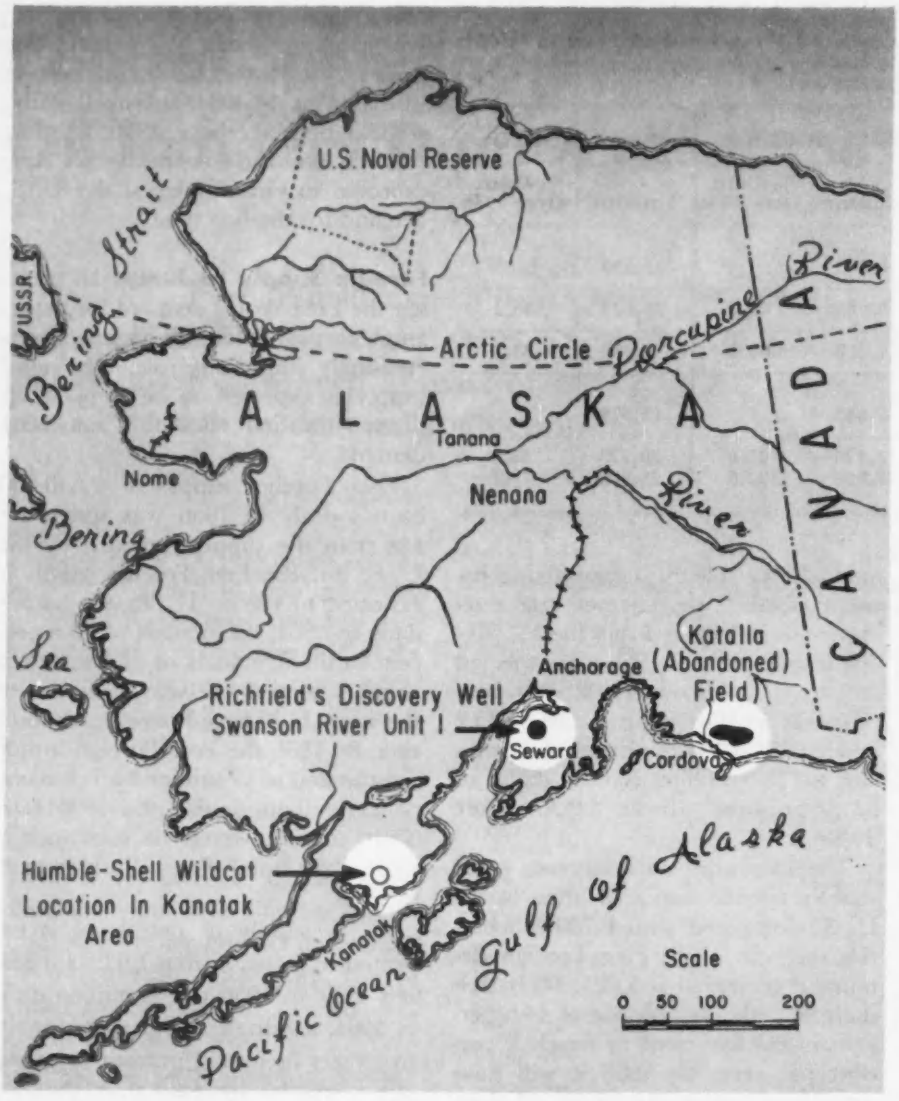
Gasoline Demand Is Rising Less Than in Prior Years

In recent months the demand for gasoline has been running only about 1 percent above last year's trend. In prior years, gains of 4 or 5 percent were common.

This year's weaker gain in demand apparently reflects: (1) a slower growth in motor vehicle registrations, and (2) an indicated lower average consumption per vehicle.

This year has brought a slowdown of the increase in U. S. motor vehicle registrations. The gain for the year will be the smallest in the past five years. The total is expected to reach 67.2 million for 1957. Passenger cars will total 56.1 million, a 3.3 percent increase over 1956. Trucks and buses are expected to total 11.1 million, an increase of 2.0 percent.

Since gasoline demand lately has been up over last year less than motor vehicle registrations, a decrease in consumption per vehicle is indicated. This possibly reflects, among other things, (1) increased use of a second or third car in a family, without doubling or tripling of gasoline consumption, and (2) increasing use of foreign and domestic small cars instead of regular size American cars.



Alaska apparently will have an important oil field, in a strategic location, as a result of a recent discovery by Richfield Oil Corporation and associates 40 miles southwest of Anchorage. The discovery well is shown here. To the east of it is the old, abandoned Katalla field. To the southwest of the Richfield discovery is the Kanatak area, where other significant drilling is scheduled. In the far northern portion of Alaska, south of Point Barrow, is the U. S. Naval Reserve, on which the U. S. Navy has found promising oil possibilities.

Leasing Active Following Oil Discovery in Alaska

• Major companies and independent operators have participated in rush for acreage.

• Richfield's discovery well is on Kenai Peninsula, 40 miles southwest of Anchorage. It flowed high gravity oil from 11,150-11,215 feet.

By Gilbert M. Wilson, WORLD OIL Staff

A NEW OIL producing province has been discovered on the North American continent. Alaska, significant and vital territory in U. S. defense, now assumes an even more important role. It is the site of an apparently highly successful strike of flowing, high gravity crude oil. The discovery is doubly significant because it is in an area conveniently close to tidewater.

The successful wildcat is Richfield Oil Corporation's Swanson River Unit No. 1, located 40 miles southwest of Anchorage on the Kenai Peninsula. The site is about 22 miles northeast of Kenai town, 35 miles westerly from Hope, and 21 miles north of Soldotna. The well was completed for a flowing production of 900 barrels per day of 33 gravity crude, cutting less than 1 percent, along with 122,000 cubic feet daily of gas through a 1½-inch bean. Subsequently, production has been pinched back to 360 barrels per day through 9/64-inch bean, flowing against 900 pounds per square inch tubing pressure and making, in addition, 50,000 cubic feet of gas per day.

Production is from the perforated interval 11,150 to 11,215 feet. The well, drilled to total depth of 12,384 feet, was plugged back to 12,000 feet. Casing program includes 9⅝-inch cemented at 9228 feet and 5½-inch liner landed at plugged depth of 12,000 feet.

Richfield, as operator of the 71,600-acre Swanson River Unit, owns 89½ percent, with Union Oil Company of California and The Ohio Oil Company each owning 5¼ percent. A second well about two miles south of the discovery is to be started soon.

Oil and gas leasing activity, spurred by the discovery, is reaching proportions reminiscent of early gold rush days. In only approximately three to four months, since news filtered out last June that possible commercial shows of oil had been encountered, leasing activity has skyrocketed. Both major and independent companies have been active. More than 12 million acres have been filed upon so far, with no sign of any slowdown.

Preparatory work was done in recent months on a scheduled 12,000 foot wildcat test by Humble Oil & Refining Company and Shell Oil Company at a site about 290 miles southwest of the Richfield discovery. The Humble wildcat will test the Bear Creek area of the Kanatak region, 325 miles southwest of Anchorage. Roads and camp facilities were being built in late summer.

Are You 'Aware' of the Public?

You will find the answer in these 50 questions designed to test the public relations attitude of company executives.

By Paul Lockwood, Richmond, Calif.

MANY EXECUTIVES think of public relations in much the same way as they do their fire fighting equipment: to be called when there is an emergency. Good public relations is preventive medicine, not the doctor or the undertaker.

What is public relations?

Even today public relations is a mystery to many businessmen. Some, for instance, consider it a high science. Others think of public relations as printed publicity. Actually, public relations is just good common business sense in the way a company conducts its business with the public. The things you and your employes do and say molds public opinion—good or bad —about your company.

You cannot go out and buy a gallon or a barrel of public relations. It is not for sale. You and your organization must create it. You must plan it. And, you must work on it to make it a success.

Here is a check list of the elements that go into making a successful public relations program. Check each of the points listed that you can honestly answer with an unqualified "yes." Then, add up your check marks, multiply by two, and you will have the score for your company's present public relations. If you score 90-100, you are public relations minded. If you score 80-90, some improvement is needed. If you score below 80, some earnest public relations soul-searching is in order.

PUBLIC RELATIONS CHECK LIST

Civic Responsibility

__Do you belong to organizations in your community in each of these classifications—church, lodge, service club?

__Do you take an active part in at least one of these organizations of which you are a member?

__Are you a strong supporter of programs designed for the civic betterment of your community even though there is no personal gain involved?

__Do you participate in the recognized worthy charity drives in your community?

__Do you contribute your business know-how, facilities and time to make every civic enterprise a success?

Personnel Relations

__Does your salary and employe benefit program compare favorably with other employer's plans in your community?

__Do you take a genuine and a sincere interest in your employes and in their problems?

__When it is necessary to discharge or lay off an employe, do you explain the situation completely to the worker?

__Do most of your advancements to better positions come from within the organization?

__Do you keep all of your employes informed about the goals, problems and position of your company all the time?

"When answering the phone, do you have a smile in your voice?"

Business Correspondence

__Do you answer all letters you receive as promptly as possible?

__Do your business letters have a pleasant, friendly tone that gives a true impression of your company?

__Do you personalize your letters so that the person receiving the letter does not feel "you say that to everyone?"

__Is there anything in your letters that might have a different meaning than the one you intended?

__Does the physical appearance of your letters create the kind of impression you want people to have of your firm?

Telephone Technique

__When answering the telephone, do you have a "smile" in your voice?

__Do you introduce yourself and give your firm identification when answering the telephone?

__Do you make it a point to get your caller's name when you start talking on the telephone?

__Do you personalize your telephone conversation by using the caller's name while talking?

__Do you always answer your telephone calls as promptly as possible?

Advertising Attitude

__Do all of your advertisements fit into the character you want to create for your company?

__Are your advertisements prepared in good taste to give people a feeling of confidence in your business?

__Do you avoid the tendency to knock your competition in your advertising?

__Do all of your advertisements have some means of identification for your business?

__Do you avoid any misleading or semi-true advertising that will be a business boomerang?

Printed Publicity

__Do you know the publisher or editor of your local newspaper personally?

__Do you keep your newspaper in-

"Do all your advertisements have some means of identification for your business?"

formed of any personal or business activity that is newsworthy?

—Do you avoid the tendency to be a "publicity grabber" for any little thing that happens?

—Do you refrain from complaining about the amount of publicity you receive in comparison with other businessmen?

—Do you give the common place publicity about your firm a different twist to make it more interesting?

Handling Complaints

—Do you make every effort to handle all complaints and adjustments promptly?

—Are you fair in all settlements offered to your customers about their complaints?

—When you are at fault, do you quickly shoulder the blame instead of grudgingly making an adjustment for the customer?

—Do you live up to the spirit as well as the letter of all agreements you make with your customers?

—When dealing with a "chronic complainer" are you fair but firm?

Supplier Relations

—Do you make it a point to see and to examine the supplies and equipment of every salesman calling on you?

—Do you treat visiting salesmen as friends rather than as business enemies?

—Do you avoid any criticism of the supplies and equipment in the salesman's line?

—Do you offer constructive suggestions that might lead to some improvement of the supplies and equipment?

—Do you avoid all sharp-trading practices such as asking for unusual terms, faster delivery and special discounts?

Creditor Relations

—Do you pay all invoices as promptly as possible within the dating allowed?

—Do you take only the discounts allowed on the invoice instead of mis-interpreting the terms or datings?

—Are you fair in seeking credits and adjustments for the supplies and equipment you purchase?

—Do you re-check carefully on any errors that seem to indicate a difference in invoice amount and the amount received?

—When it is necessary to delay payment of an invoice for some reason, do you inform the supplier of the situation?

Controversial Issues

—Do you cooperate fully with government officials and the press when investigations and controversial issues arise?

—When you know in advance that controversial issues (e.g., the Harris Bill) are pending, do you start early to give your employes the complete facts concerning oil's side of the controversy?

—Do you keep your stockholders well informed about oil's side of controversial issues?

—Do you give full support to groups and individuals who support the petroleum industry in answering investigations and charges?

—Do you support industry efforts to curb legislation injurious to oil, even though it may only indirectly affect petroleum operations (e.g., depletion allowance)?

"Do you treat visiting salesmen as friends rather than as business enemies?"

These 50 questions will give you a cross-section of your public relations program. All are important to the future success of your business and all have a bearing on the opinion the public will have of your company. By applying good common business sense to any areas that show a weakness, you can improve your public relations in your community.

—The End

How to Live Longer . . . and Like It!

The recipe for a happier, healthier, longer life is simple: Be as careful with your personal 'machine' as you are with those in your oil field operations.

By Ernest W. Fair, Boulder, Colo.

"THERE'S NO more cantankerous individual—when it comes to taking care of himself—than the modern business or professional man," a doctor declared recently. "He'll rush the kids to the hospital on the slightest pretext and yell for the family doctor every time his wife looks tired—but take care of himself? He never does it until he's had a good scare at least once!"

Learning through the "good scare" route isn't wise. Far too often that incident turns out to be the actual end of the line.

"Accumulated nervous tension," another doctor warns, "damages more business men's constitutions than anything else I've noticed. Maybe it's the tempo of today's business or maybe it's something else, but one big thing is that we're not taking enough time to relax anymore."

Relaxing is more important than one may think at first reflection. It should be both mental and physical.

Not one executive in a hundred can go home from his office and forget his business without a powerful interest to completely dominate it. Ordinary pasttime pursuits will provide interludes but not complete freedom. Going on day after day and night after night with concentration on a single theme can put some men on the "happy farm." For most, the result is broken health and inability to properly plan their business lives.

"We never hire a junior executive who hasn't learned to separate his business from his home life," the head of a large national organization says. "The executive who can approach his business with a fresh and alert mind every morning is the one who has left his business in the office the night before."

It takes top health to have the mental and physical energy to make intelligent decisions—it takes top health to be ready for the unexpected emergencies in the life of one's business—it takes top health to be the kind of business executive who inspires results from the people around him.

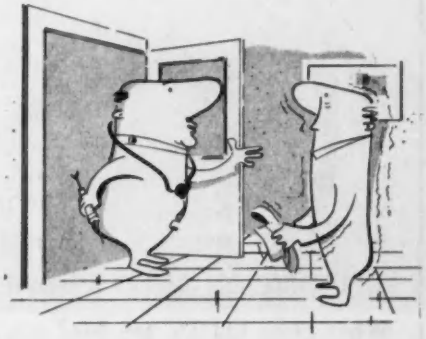
There are as many "systems" for guiding one's health as there are subparagraphs in a government regulation. Some are good and some are bad, but medical men generally will advise that "fads" and "easy-to-follow" schemes are generally not only worthless but—what is more important—dangerous!

There is no "magic formula" to good health for any executive. But there are a few steps that every one can use. The results will offer no assurance of living forever but they will give a person more out of the life.

Those steps are as follows:

1. *Know Your Doctor as a Friend.* Too many of us look on the family doctor as the caretaker of our children and of our wives . . . never consider him our own caretaker and friend as well. The doctor's ability to help any of us depends on his knowing all about us *all of the time.*

2. *See the Family Doctor Regularly.* A check-up of one's physical and mental condition is just as important as a maintenance check-up on our equipment. The average life expectancy of all of us has leaped in the past twenty-five years because of the wonders of preventive medicine. None of these advantages can be ours if our doctor cannot discover the need for them early.



3. *Check Every Idea With the Family Doctor.* When we're feeling low, there's always someone ready to step forward with a sure-cure nostrum or a big health idea to solve our problem. Our wisest bet is to listen courteously and then check with the family doctor before we do anything. Some of those ideas may work well with the other fellow and not only be of no value whatever to us but they can be harmful.

4. *Relax—Mister—Relax!* We can run the motor in our car without rest for just so long, and it will start becoming sluggish, lose its power and demand attention from the "Motor Medic." the same thing holds true for the human body; its ability to keep going at top speed is good, but limited. Slow down, give every part of the body's machine a rest, and it will keep functioning at peak efficiency much longer.

5. *Follow Simple Health Rules.* Medicine has learned a lot in the past twenty years and all for our benefit; but unless we listen and put into practice these principles, all of this accumulated knowledge does no good whatever. Here's a suggestion: Insurance companies are vitally interested in our living as long as possible, so they have all sorts of very good literature on how to prolong life. All you have to do is ask your agent for it—and follow the simple rules of good health laid down in these booklets.

6. *Know the Danger Signs.* When that clatter-bang starts coming out of the family car, you know there's trouble in the engine and rush to a garage. When something goes wrong with a lot of us we reach for a pill and forget all about it until the next time. The clatter-bang is the car engine's warning of trouble—so is that out-of-ordinary clamor in our own physical make-up. It's no time for a pill; it's time to have a check with the family doctor and see what the warning is about so something can be done about it right now.

The great majority of cancer deaths can be avoided, we are told, if it can be spotted in first stages. So can nervous breakdowns, and a lot of other mental and physical ailments. We have a marvelous piece of machinery in the human body, and it's loaded with scores of safety valves and warning signals, if we but listen to the warnings when they occur.

7. *"Worry Gets Most Businessmen."* No matter how tough the problem, how large and hungry the wolf at one's doorstep, or how unsurmountable the latest tax problem appears . . . worry and fret about them will do no good.

"When I catch myself starting to worry about one of my business problems," an engineer commented recently, "I grab my hat and get out of the place as fast as I can—rush home, pack my fishing gear, and head for the nearest angling spot. The problem always waits for me, and when I come back I'm in much better shape to work it out because I didn't let worry completely overpower my ability to reason out the predicament."

8. *"We Can't All Be Henry Kaisers!"* Doctors say over-powering ambition has shortened many a businessman's life from five to twenty years. Trying to do too much always results in fatigue. The physical kind we readily spot; mental fatigue seldom shows up until it's too late.

9. *Develop an Easy Disposition.* That's a large order for many people because of the way they are put together. However, just as frequent high-speed spurts on the automobile engine are damaging; so are tempers, tantrums and fits of anger damaging to the body machine.

10. *Play the Health Odds as Close as You Play Poker Odds.* Few men would pay $100 in a poker game to draw two cards to an inside straight, but they will take on the same impossible odds with their health. Working late three nights in a row is such a procedure—taking on more than you can handle in the business world is another.

You can't live forever, but you can live much longer and enjoy it more fully, if you give the same attention to your personal "machine" as you do to those you use in your oil field operations. **—The End**

If Oil Could Speak

If oil could speak it would have many fascinating truths to tell the non-oil public—truths that would win thousands of new friends for the oil industry.

But, oil can't speak—you can. You, as an individual, can win many new friends for the oil industry if you will pass the true facts on to your non-oil industry friends.

Here are some of those true facts. They are being presented for one purpose: To keep you posted on your industry, so you can tell the story oil is unable to relate.

Read these facts. You will find them informative—and interesting.

"If Oil Could Speak" it would tell the American public:

What Does Oil Do for Me?

The energy obtained yearly from crude oil and natural gas is the equivalent of the work of 33 servants for every man, woman and child in the nation.

Are Gasoline Prices Too High?

Motorists who know that they pay more for their gasoline today may wonder about the industry's claim that in 1957 two gallons of gasoline does the work of three gallons in 1925—yet costs about the same. This is hard for the motorists to believe, unless he realizes that 7.35 cents of every gallon of gasoline he buys is tax collected for the federal and state governments—that he pays an average of $51.37 a year in direct state and federal gasoline taxes.

Is Every Oil Well a Gusher?

The cold fact is that the average well produces an average of 12.6 barrels daily, because of the number of old field producers and allowables.

Is It True that High Octane Gasolines Raise the Operating Temperatures of Engine Parts, thereby tending to cause an Engine to Burn Up?

Modern automotive gasolines of both premium and regular grades have practically identical heating values—approximately 115,000 BTU per gallon. Also, there is no predictable correlation between heating value and octane number. Therefore, switching to a gasoline of higher octane number will not produce any change in operating temperature unless the engine has been knocking. In this case the operating temperature actually will be reduced.

Machining spur gears made from Bethlehem forged-and-rolled blanks.

When the Blank is Sound, Machining Costs Go Down

You probably know a machinist whose specialty is gears. Some day ask him what a sound blank means in terms of machining speed. Ask him how a sound blank reduces costs.

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Safety Begins at the Employment Desk

Application forms can be a useful tool in reducing accidents—particularly in weeding out the "accident prone" worker.

By G. H. THOMPSON
Imperial Oil, Limited
Edmonton, Alberta

STATISTICS SHOW that of 100 men employed, 20 will be of a superior type, 60 will be average and 20 will be of an inferior type. The latter 20 percent are the main contributors to a high frequency rate of accidents.

By following a careful screening process, making use of all the available information on an application form, the employment officer may be able to improve the statistics to come up with 20 superior employes, 70 average and only 10 inferior.

How Can Application Forms Promote Safety? They make available at once such information as age, marital status, education, previous employers, etc. These items provide information useful to the employment officer in the important undertaking of screening job applicants.

It is interesting to see how just this much information can be of real importance to an employment officer in the oil industry. The first item of age is important because the oil industry does not employ any person for field work who is not 20 years of age. In most cases applicants who have reached 21 years are preferred. This is because statistics indicate that from the age of 25 downward, the frequency rate of accidents increases until it reaches an alarming incidence among those persons under 21. The industry feels it has reduced its accident experience simply by not employing those persons shown to be more liable to suffer disabling injury.

Marital status, too, can assist the employment officer in a decision. Again, statistics indicate the married employe—all other things being equal—is more inclined to work safely. This does not eliminate the employment of single persons but it often does put the married applicant in a favored position. Usually the married employe has begun to recognize his responsibilities and has become a more stable individual. By considering such factors, as shown on a job application card, the employment officer can reduce the liability against a careless or unsafe worker.

The question of educational standards is important to safety programs too. It is generally agreed that a senior matriculation or final high school diploma is not necessary for a man to be a good refinery employe or to make him less liable to suffer an accident. But it also is agreed that senior matriculation indicates two interesting traits about an individual.

First, it seems reasonable to assume that a person who has completed Grade 12 exhibits a higher degree of intelligence than an applicant who left school at Grade Eight, or even Grades Nine or Ten. Second, completing a senior matriculation indicates the applicant may be able to concentrate on his work, to develop a higher degree of skill in his work and be able to absorb training more readily.

Further down most application forms, space usually is provided to list the previous places of employment and types of work followed in the previous ten year period. Here again, the employment officer can find clues to the applicant's nature, knowledge and ability.

If the applicant has been engaged in work similar to that for which he is being considered, the chances are good he will require a minimum amount of training on the new job. If he lists only two or three employers during the previous 10 years, it could indicate a stable nature. It could also mean the applicant is industrious, seeking to better his position by making a worthwhile change. Conversely, the types of work listed may indicate the fly-by-night employe, who has switched jobs frequently and probably will do so again. Usually he is an uninterested worker and often careless on the job.

Even the space in which the applicant lists any special talents or training and indicates his hobbies and special interests, can be helpful. It is not necessary in most jobs for an applicant to speak several languages, but that information still might indicate a stable, ambitious person. Hobbies, too, give some direction as to personality and character.

On the other hand, many employment officers make little use of the references asked for and listed. In many cases the applicant lists several personal friends among those who know him and are willing to speak in

support of his job application. Personal friends too often give biased reports when asked to comment on the applicant, thus minimizing the usefulness of the information.

Indoctrination Promotes Safety. Up to this point, the personnel man has performed only a portion of his job for management. Every employer seeks a minimum turnover of personnel. When that minimum is achieved it means reduced training time, employes develop a sense of "belonging" and the efficiency of a work force increases as a result.

That being so, it seems obvious that some care should be taken with the induction of a new employe. Many employers have fallen down on this matter of induction, according to some labor authorities. It is argued that employers must try to establish in the new worker's mind that new opportunity awaits him in a position that offers a good future with opportunity for advancement, increased earnings and job security. He should be made to feel he is an important part of the organization he has just joined.

Proper job induction must go still further, for even if the new employe is totally inexperienced or if he has worked in a similar occupation with another firm, he must be made acquainted with the new job. In the oil industry, if he is to work with a crew of men, he should be introduced to each crew member. Procedures used on the job must be explained, covering the overall operation in general and the man's particular job in detail. Such precautions will reduce the number of disabling injuries suffered by employes during the first two or three hours or shifts on a new job.

Weed Out the Unsafe. Studies have been made to determine if employe screening has helped in the problem of the accident-prone worker. In making comparisons it was necessary, first, to define "accident-prone." A widely accepted definition states: "An accident prone person is one whose characteristics and behavior are such as to make him considerably more liable to injury than the average person." Such a person will not respond satisfactorily to the usual methods of training.

Nor is he the same as the "accident repeater." The latter may have more than one accident but often these are the result of other circumstances, such as material or equipment failure, and whose experience can be corrected with a proper training program. But the accident-prone worker, whom industry strives to avoid, comes within the 20 percent group acknowledged to be of inferior ability. Only careful screening can catch him before he is signed to the payroll. If intelligent selection methods are not followed, the accident-prone workman may infiltrate an organization with a resultant increase in the frequency rate of accidents.

On the other hand, the accident repeater is known to be the result of other causes. First, it may be physical inadequacies such as eyesight or hearing, nervousness or a lack of physical ability for a particular job. The preemployment medical will bring most of these to light and the information is passed along to the contact supervisor. Such a man still is employable but subject to certain work limitations. Frequency of accidents he will suffer will be in direct proportion to the attention given to correction of his physical inadequacies.

Motivation faults may contribute further to mishaps by the repeater. These could be distaste for the job, lack of will to work, dislike of a supervisor of fellow workers, or both. Situations like this often come to the attention of a personnel officer and it is his responsibility to suggest remedial action. If such is taken there is less likelihood of the employe suffering disabling injury.

Two other factors which may cause accidents are lack of sufficient intelligence and lack of sufficient manual skill to perform work properly or accurately. So far as the first is concerned, it is the responsibility of screening officers to see that workers lacking in intelligence do not get into an organization.

The lack of manual skill is known to be the cause of many accidents. Development of skill to required levels often can be achieved through help from supervisors, but planning proper training programs to make such development possible can be the responsibility of personnel departments. To insure that supervisors accept responsibility for their parts in training programs, it is necessary that all levels of management show concern and support steps taken to increase workers' skills.

Management must face up to its responsibilities regarding the individual who does not respond to training. Such a worker should not be permitted to continue on the job. If no other job is available within his capacities, his services should be terminated.

Some supervisors are reluctant to fire any worker, but an employe is done no favor by being kept on a payroll if he faces possible disabling injury on the job. The worker who can not increase his competence through training should not be prolonged in a job for which he is unfit. The longer he remains in such a job, the less chance there is of his getting established in work at which he can be a success.

Use Appraisal Reports. But all this attention and effort in the selection of new employes is wasted unless a continuing program is followed to determine their real worth. In this respect, the personnel department can play a useful part by maintaining a series of appraisal reports. This method is followed in many firms, with reports compiled at regular intervals during employment.

It is believed that if work is not satisfactory, it cannot be corrected unless the employe is made aware of his shortcomings. To establish those, regular appraisals are needed to make efficiency assessments. If work is satisfactory, the employe is told and he is encouraged to continue to improve. Firms using appraisal report methods believe that if such a program is successful more skilled workmen will be developed, automatically developing safer workers and automatically reducing the frequency rate of accidents.

The personnel officer has an important role in this if he is assigned the responsibility for developing suitable on-the-job training programs. He can assist management in spotting training needs and developing training programs to meet those needs. It is an overall management responsibility. There is no point in defining the employe's shortcomings if no plans are made to help him correct poor work habits. —The End

Producing Ability in U. S. Far Above Current Output

The U. S. in January 1957 had the capacity to produce 9,867,000 barrels daily of crude oil and 845,000 of natural gas liquids, a total of 10,712,000 barrels daily. These estimates were made by the National Petroleum Council's committee on petroleum productive capacity, headed by L. F. McCollum, president, Continental Oil Company, Houston.

Previous studies showed comparable total capacity of 9.1 million barrels daily in July 1954 and 8.2 million in January 1953. In the 2½ years ended last January the productive capacity increased at about the same annual rate as in the preceding 1½ years.

In January of this year the productive capacity exceeded actual production by 2,406,000 barrels daily. That unused capacity was 194,000 greater than the 2,212,000 barrels per day in July 1954.

Output Below Capacity. In September, 1957, production totaled about 7,500,000 barrels daily, or about 3,160,000 less than the latest estimate of productive capacity. In October 1957 the production was due to decrease further by about 200,000 barrels daily and the unused capacity to rise the same amount to about 3,350,000 barrels daily. Currently, therefore, the U. S. is making use of only 68.7 percent of its producing capacity, while 31.1 percent is not utilized.

Actually, facilities would not be available for transporting, handling, and marketing all potential production. The facilities were fairly well employed to the fullest extent possible at the peak of production in March 1957. At that time production averaged 8,543,000 barrels daily, or within 2,169,000 barrels of the productive capacity. The production was equivalent to 79.8 percent of capacity, and the reserve or unused potential was 20.2 percent of the total capacity.

Capacity Would Drop Without Drilling. The NPC committee stated that the currently estimated productive capacity could not be sustained for more than a brief period without drilling additional wells. It said that the decline to be expected was hard to estimate because of no industry experience without drilling. But a qualified estimate of 7.5 percent in the first year of no drilling was offered. That would be a drop of about 800,000 barrels per day in the producing capacity for the first year.

In the event of an emergency, curtailment of drilling would have serious immediate effects and equally serious after effects, the committee stated, because of the inevitable loss of trained drilling crews to other emergency activities.

The committee estimated that it probably would require 41,000 to 50,000 wells a year merely to maintain productive capacity, without adding to it regularly as heretofore. The exact number would depend upon the proportion of productive wells to dry holes and the quality of the successful wells. The industry drilled 55,879 wells in 1955, 58,418 in 1956, and will drill an estimated 55,670 wells in 1957 (WORLD OIL, August 15, 1957, Page 122).

Can Produce Reserves Faster. The U. S. industry currently is able to produce its reserves at a higher rate than in World War II, the committee stated. This is because of improved technology and more intensive development of proved reserves. Things making possible the higher producing rates include multiple completions of wells in two or more zones; formation fracturing, which permits recovering oil faster; and increased volumes of production by water flooding, which provides production in relatively high ratio to reserves.

Nevertheless, stated the committee, there should be no relaxation of the industry's efforts to find and develop new reserves. It must develop enough new reserves, said the committee, to keep pace with the steady growth in peacetime demand for petroleum and to maintain at the same time sufficient reserve capacity for any sudden emergency.

Industry Using 2.2 Barrels Tankage for 1 of Inventory

The petroleum industry of the U. S. continues to find it necessary to maintain over-all storage capacity of more than two barrels for each barrel of inventory. This was reported by the National Petroleum Council's committee on petroleum storage capacity, headed by Robert L. Milligan, president, The Pure Oil Company, Chicago.

The March 31, 1957, ratio was 2.2 barrels of capacity to 1 of inventory. That compared with ratios of 2.1 to 1 on March 31, 1954; 2.2 to 1 in 1952 and 1950; and 2.4 to 1 in 1948.

The nation's storage capacity for clean products (gasoline, kerosine, and distillate fuels) increased almost 19 percent between 1954 and 1957. Storage for crude oil and for residual fuel oils both declined about 2 percent in the same period.

Crude Oil. Total aboveground storage capacity for crude oil on March 31, 1957, was 415 million barrels, compared with 425 million in 1954 and 417 million in 1948.

The 415 million barrels of tankage contained 173 million barrels of crude, indicating that the tanks were 42 percent full.

Total crude stocks on March 31, 1957, in tanks and all other facilities, including tankers and pipe lines but excluding producers' lease stocks and cargoes in transit from foreign countries, were 226 million barrels. This represented a decline of 18 million barrels from 1954.

Of the 226 million barrels of stocks, 158 million or 70 percent were listed by the committee as unavailable. Pipe line fill and amounts required to assure continuous operation of these lines accounted for 106 million of the unavailable barrels.

This left an available total of 68 million barrels for immediate consumption and seasonal accumulation as well as for working stocks. Available stocks were 77 million barrels in 1954.

The committee pointed out that since the first storage survey made in 1948, crude stocks have risen only 13 million barrels, or 6 percent, in a pe-

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riod when demand increased 44 percent. Available stocks were off 12 million barrels in the same 1948-57 period. A rise of 25 million barrels in unavailable stocks is accounted for principally by the nine-year increase of 16 million barrels in pipe line fill and an increase of 7 million barrels required in refinery pipe lines and in amounts necessary to assure continuous operations.

Clean Products. The committee's analysis of clean products inventories indicated that unavailable stocks increased 28 million barrels since 1948, with 10 million barrels of this being accounted for by additional pipe line fill requirements and 5 million barrels by increased pipe line operating requirements.

Total stocks held were 294 million barrels on March 31, 1957; 251 million in 1954, and 150 in 1948. Unavailable stocks were 104 million in 1957; 92 million in 1954; and 75 million in 1948. Available stocks totaled 191 million barrels this year against 160 million in 1954 and 75 million in 1948. The unavailable percentage of the total reported declined from 50 percent in 1948 to 35 percent in 1957.

Total storage capacity for clean products at March 31, 1957, was 559 million barrels. Of this, 271 million was in tanks, indicating that tanks were 48 percent full.

The 1957 report was the first that studied gasoline, kerosine, and distillate fuel oils separately. The report showed that gasoline storage capacity was 55 percent full on March 31 of this year; kerosine, 41 percent; and distillate fuel oil, 38 percent. The survey was made at a time when gasoline storage was near its seasonal peak while kerosine and distillate fuel oils were approaching seasonal lows.

The report also indicated that 36 percent of the gasoline, 33 percent of the kerosine, and 34 percent of the distillate fuel oil were in the unavailable categories on March 31, 1957.

Residual Fuel Oil. About 38 percent of the total reported inventories of 37 million barrels of residual fuel oil was unavailable on March 31, 1957. But 62 percent could be shipped against current demand or held as part of the required seasonal buildup. Storage capacity of 97 million barrels, including 29 million barrels of reservoir storage in California, with only 36 percent full.

Sharp Gain in Production Of LPG Would Be Possible

U. S. production of liquefied petroleum gas products from present facilities could be increased about 44 percent above its 1956 rate in a national emergency requiring the lifting of proration of crude oil and natural gas production. Through facilities that might be expanded to recover as much as possible from the available gas supply, the country could boost LPG production 81 percent above the 1956 rate.

These estimates were made, following a survey, by the National Petroleum Council's committee on availability of liquefied petroleum gas, headed by W. K. Warren, board chairman, Warren Petroleum Corporation, Tulsa.

Actual LPG production in 1956 was 8,482,059,000 gallons. There will be an increase of 816,619,000 gallons in annual productive capacity at new and present plants during 1957.

Following 1957 expansion, present plants, in absence of proration, could make available 12,189,542,000 gallons of LPG annually. If facilities were expanded to recover as much as possible from the available gas supply, LPG production, without proration, could be boosted to 15,383,003,000 gallons.

Plants Being Expanded. LPG availability in 1957 will increase in all 13 refining districts, the report showed. But the amount of increase will vary from less than 5 percent of 1956 production in four of the districts to more than 20 percent in four others.

Under emergency conditions the greatest potential increase in availability over present actual production would be in the Texas Inland, Texas Gulf Coast, and Oklahoma-Kansas-Missouri refining districts.

Under both normal and emergency conditions, availability of all individual LPG products would increase, the committee stated, with exception of butane-propane mixtures.

Under normal conditions the larger increase in LPG availability would be at refineries. But under emergency conditions the larger increase would be at natural gas liquids plants.

New Liner Gives More Oil Recovery From Loose Sand

A new liner, having a design unlike anything else now in use, currently is undergoing successful tests in California. It appears to have excellent application in heavy oil, loose sand, and liner-collapse problem areas.

The new type liner is credited with making possible the completion of highly successful wells in an otherwise marginal area. In the area a thick section of loose, unconsolidated sand caused high cost pulling and maintenance operations.

One well, completed with a conventional slotted liner, when on production, averaged about 25 barrels daily of 10-gravity oil, cutting as much as 80 percent sand. That condition required very frequent pulling and clean-out operations.

A new offset well, drilled into the same sand, but completed with the new type liner, had no sand problems or hole caving. It leveled off at a rate of production approximately three times higher than the offset conventionally-equipped well.

Still another well, completed with the new liner, is giving evidence of the same highly satisfactory performance.

The liner actually consists of two liners, the inner one being a conventional slotted pipe. The outside section is a series of slotted convex bowls that are welded individually to the inner pipe.

Slot size and placement are carefully designed to produce a more even rate of flow from formation into the well. This condition allows a maximum amount of fluid to pass, but without bringing in excessive amounts of sand.

The double wall design also provides a far greater resistance to bend or collapse than does conventional single-wall slotted pipe of the same size.

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Hearing him talk that way always makes us feel good . . . because that production superintendent is so typical of many others in the areas we serve.

We're mighty sure that customer good will has helped us build from virtually nothing, twenty years ago, to a network that now includes sixty-one stores. Today Bethlehem Supply covers a pretty big territory—from eastern Illinois to the Pacific, and from the Gulf Coast to North Dakota. That's our domestic spread. And Bethlehem Supply Company of Canada, Ltd. has recently opened an office at Calgary, Alberta, and a full-fledged store in Edmonton.

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BETHLEHEM SUPPLY

BETHLEHEM STEEL

By Ray L. Dudley, Publisher, and **Warren L. Baker,** Editorial Director

U. S. Producers May Get Some Relief

Approaching winter peak demand, coupled with declining crude imports and low domestic producing rates, should correct excessive stocks.

The drastic economic squeeze in which U. S. crude oil producers have found themselves in recent months will continue through 1957. However, there is promise that subsequent months may see some relief, although there is little hope for any immediate substantial relief from recent low producing allowables.

Chief hope for relief hinges on the approach of winter weather. Demand will begin rising in November, and continue growing until it reaches an annual peak in January or February. A very cold, long winter in the northern sectors of the U. S. would boost oil consumption sufficiently to overcome much of the industry's present oversupply conditions.

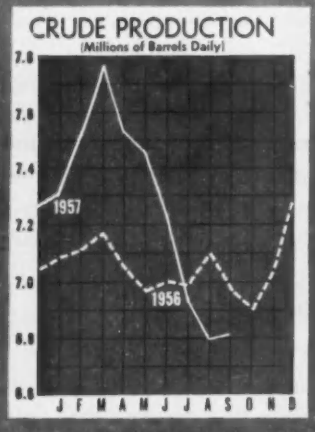
To fully benefit from prospective higher demand, the industry should continue the good job it has been doing in tailoring its operations to fit existing conditions. Therefore, the industry must proceed with caution. Despite the severity of recent curtailments, the industry should not be too anxious to increase producing and refining rates.

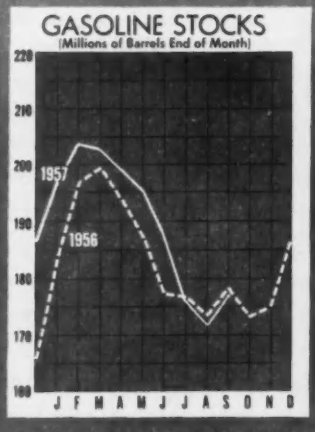
It is desirable that higher demand be used to cure excessive inventories, before realizing too much relief from recent low operating rates.

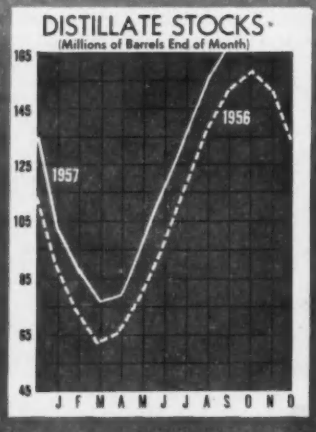
Prospects that the industry will be able to cure excessive supplies have been brightened by the way production and refining operations have been curtailed, and by recent indications that crude imports are to be reduced to near the government quota. These prospects promise needed reduction in crude oil stocks.

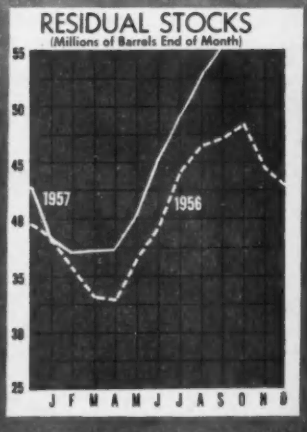
If refiners continue to hold crude runs to stills to recent low levels, some improvement in the heavy inventories of distillate fuel oil also should be

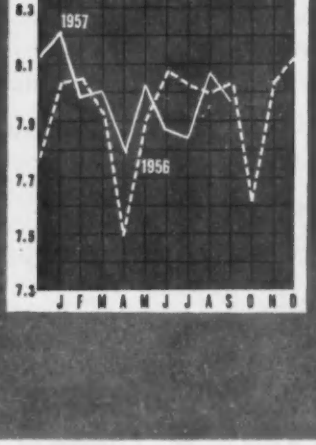
Petroleum Trends . . .

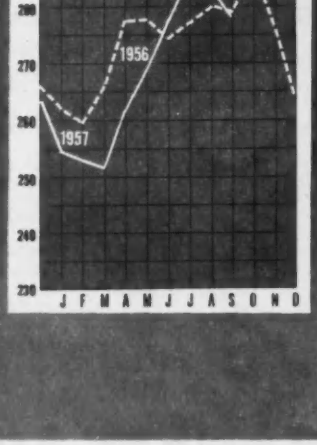


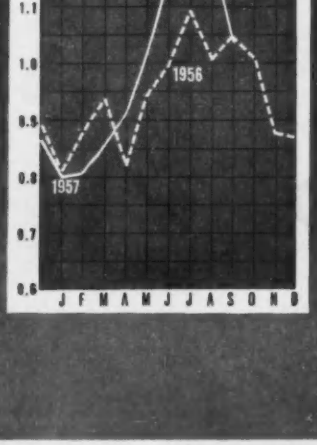


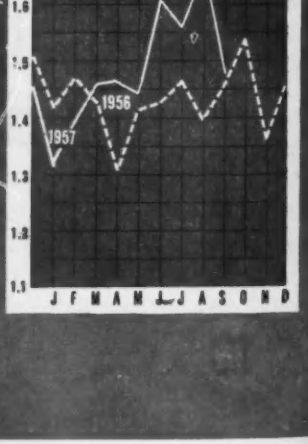












realized without adding seriously to motor fuel stocks.

If the prospects for curing some of the current excessive inventories are fulfilled, the industry will have taken a long step toward putting its house in order. Failure to take advantage of this possibility during the next three or four months will only mean additional market difficulties next spring.

Little improvement occurred in the U. S. crude oil picture during recent weeks, as demand fell short of expectations. This was extremely disappointing in view of reduced imports and the low level of domestic production.

Crude oil stocks rose 1.2 million barrels during the latest four weeks ended October 11. In totaling 283.3 million barrels on October 11, crude stocks were down only slightly since the end of July and near a two-year peak.

Crude inventories failed to show much change despite production being held at a two-year low of 6.8 million barrels daily since the end of July. This compared with the output of 7.7 million barrels last March.

Highly encouraging to U. S. producers was the reduction in crude imports during recent weeks. Excluding the West Coast, U. S. imports averaged only 766,800 barrels daily during the four weeks ended October 11. This was only 10,000 barrels above the government quota, and but 23,500 barrels larger than during the corresponding period a year ago.

Crude production in November will be only slightly larger than the October low. If imports continue to decline, higher November demand should result in a reduction in crude stocks.

No improvement occurred in the refined product market during recent weeks. Again, this was the result of low demand, as U. S. refiners continued to hold crude runs to 7.8 million barrels per day, the lowest level since last March.

Nevertheless, U. S. gasoline inventories rose 4 million barrels during the four weeks ended October 11, and now are 3.8 million barrels greater than a year ago. Steps must be taken to prevent too much growth in motor fuel stocks during coming winter months.

Meanwhile, nearly 10 million barrels were added to already excessive distillate fuel oil stocks during the last four weeks. These inventories now are at an all-time high of 172.7 million barrels, 18.5 million barrels above a year ago.

Therefore, it is important that refiners continue to hold refining operations to low levels. If this is done, higher demand will reduce excessive distillate stocks and prevent too much gasoline going into storage.

U. S. Crude Production by States (Thousands of Barrels)

STATE or DISTRICT	DAILY AVERAGE PRODUCTION Sept., 1957	August, 1957	Sept., 1956	% Diff. 1957-1956	TOTAL PRODUCTION First Nine Months 1957	1956	% Diff. 1957-1956
Alabama	15.6	14.2	9.2	+ 69.6	3,944	2,034	+ 93.9
Arkansas	81.1	84.1	79.6	+ 1.9	22,952	21,616	+ 6.2
California	929.0	925.3	958.8	— 3.1	253,982	264,141	— 3.9
Colorado	148.6	149.9	160.0	— 7.1	41,766	44,100	— 5.3
Florida	1.3	1.2	1.3	.....	343	363	— 5.5
Illinois	224.0	166.7	235.8	— 5.0	55,813	61,418	— 9.1
Indiana	34.0	29.1	31.3	+ 8.6	9,491	8,238	+ 15.2
Kansas	334.1	340.2	338.5	— 1.3	91,004	93,359	— 2.5
Kentucky	46.5	39.6	46.8	— 0.7	12,478	13,055	— 4.4
Louisiana	786.3	796.8	788.7	— 0.3	248,696	219,232	+ 13.4
North Louisiana	124.3	125.8	121.4	+ 2.4	36,223	34,725	+ 4.3
South Louisiana	662.0	671.0	667.3	— 0.8	212,473	184,507	+ 15.2
Michigan	27.4	27.5	28.1	— 2.5	7,696	8,198	— 6.1
Mississippi	103.7	108.0	113.4	— 8.6	30,119	30,307	— 0.6
Missouri	0.1	0.1	0.2	— 50.0	43	45	— 4.5
Montana	74.9	75.1	64.0	+ 17.0	20,037	15,721	+ 27.5
Nebraska	55.7	54.9	38.5	+ 44.7	14,028	11,814	+ 18.7
Nevada	0.1	0.1	0.2	— 50.0	26	51	— 49.0
New Mexico	250.9	249.2	239.9	+ 4.6	70,500	65,327	+ 7.9
Southeast New Mexico	246.8	244.7	238.0	+ 3.7	68,970	64,302	+ 7.3
Northwest New Mexico	4.1	4.5	1.9	+115.8	1,530	1,025	+ 49.3
New York	8.0	7.5	7.9	+ 1.3	2,053	2,050	+ 0.1
North Dakota	24.9	37.5	33.0	— 24.6	10,315	10,029	+ 2.9
Ohio	16.8	15.3	13.9	+ 20.9	3,975	3,534	+ 12.5
Oklahoma	557.2	555.1	580.5	— 4.0	162,109	161,733	+ 0.2
Pennsylvania	23.0	23.8	22.7	+ 1.3	6,323	6,142	+ 2.9
South Dakota	0.2	0.2	0.1	+100.0	30	26	+ 15.4
Tennessee	0.1	0.1	.....	.....	7	7	.....
Texas	2,763.2	2,799.2	2,958.8	— 6.6	833,209	834,522	— 0.2
Dist. 1: South Central	49.9	51.0	56.4	— 11.5	14,890	14,932	— 0.3
Dist. 2: Middle Gulf	133.0	133.3	150.3	— 11.5	41,194	42,917	— 4.0
Dist. 3: Upper Gulf	417.7	425.7	441.2	— 5.3	123,455	124,382	— 0.8
Dist. 4: Lower Gulf	212.4	214.4	240.2	— 11.6	63,806	67,026	— 4.8
Dist. 5: East Central	35.5	35.9	42.7	— 16.9	10,831	12,372	— 12.5
Dist. 6: Northeast	294.5	298.5	330.7	— 11.0	91,591	94,217	— 2.8
Dist. 7-B: North Central	152.3	150.2	158.9	— 4.2	44,130	42,872	+ 2.9
Dist. 7-C: West Central	145.3	145.5	182.8	— 20.5	44,638	50,855	— 12.2
Dist. 8: West	1,011.0	1,026.1	1,041.5	— 3.3	308,299	286,584	+ 7.6
Dist. 9: North	204.6	203.0	213.3	— 4.1	57,459	57,895	— 0.8
Dist. 10: Panhandle	107.0	106.6	100.8	+ 6.2	28,746	26,249	+ 9.5
Utah	11.3	10.9	5.5	+105.5	2,783	1,563	+ 78.1
Virginia	0.1	0.1	0.1	.....	9	7	+ 28.6
West Virginia	6.4	6.1	6.1	+ 4.9	1,658	1,644	+ 0.9
Wyoming	297.3	290.7	283.1	+ 5.0	79,435	78,362	+ 1.4
Total United States	6,8321.8	6,799.5	7,046.0	— 3.2	1,984,824	1,958,638	+ 1.3

Source: Bureau of Mines and API. Texas Districts from API and do not necessarily agree with State totals.

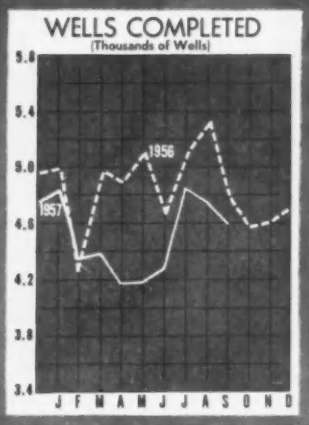
U. S. Crude Oil and Refined Product Trends

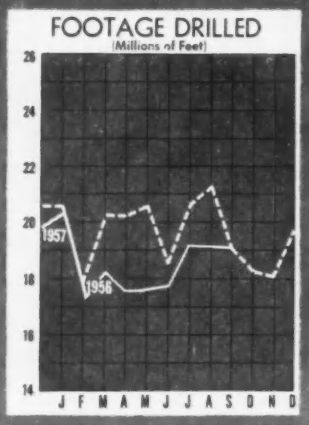
(THOUSANDS OF BARRELS)

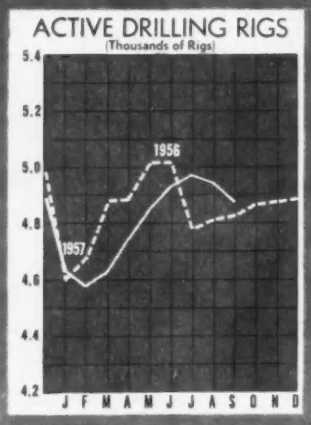
MONTH	CRUDE OIL Production Daily	Runs to Stills Daily	Stocks End of Month	GASOLINE Production Daily	Stocks End of Month	DISTILLATE FUEL Production Daily	Stocks End of Month	RESIDUAL FUEL Production Daily	Stocks End of Month	DAILY IMPORTS Crude Oil	Total Oils
1956:											
January	7,199	8,023	261,592	3,927	183,905	1,923	86,141	1,344	38,247	805	1,422
February	7,208	8,047	259,504	3,854	196,092	1,918	71,335	1,286	35,675	878	1,472
March	7,278	7,914	265,683	3,829	199,698	1,808	60,846	1,213	32,984	934	1,425
April	7,146	7,487	277,121	3,646	193,299	1,713	63,571	1,130	32,740	815	1,305
May	7,064	7,896	277,497	3,859	186,673	1,667	75,928	1,149	36,607	938	1,416
June	7,100	8,071	274,491	3,976	177,076	1,755	93,758	1,098	39,073	987	1,426
July	7,090	8,014	277,008	3,975	176,536	1,767	115,787	1,066	43,958	1,084	1,463
August	7,195	7,995	279,944	4,037	172,939	1,839	137,905	1,091	46,617	1,001	1,399
September	7,054	8,024	278,791	3,991	177,974	1,845	150,411	1,062	47,342	1,043	1,452
October	6,966	7,608	286,560	3,773	172,798	1,772	158,871	1,082	48,400	1,004	1,541
November	7,139	8,031	275,995	3,913	174,808	1,841	151,517	1,182	44,590	871	1,362
December	7,377	8,141	266,014	4,039	187,271	1,981	133,981	1,288	44,491	873	1,471
1957:											
January	7,480	8,274	256,669	3,991	197,702	2,118	100,572	1,322	38,403	805	1,421
February	7,682	8,088	256,344	3,864	205,270	2,035	85,105	1,270	36,201	780	1,430
March	7,717	8,047	254,911	3,826	206,716	1,861	76,245	1,205	37,371	836	1,464
April	7,541	7,740	265,796	3,770	201,407	1,764	78,743	1,132	37,429	906	1,542
May	7,442	7,992	275,963	3,900	194,770	1,789	98,135	1,103	41,125	1,042	1,558
June	7,107	7,867	284,312	3,984	177,997	1,773	117,364	1,101	45,572	1,147	1,606
July	6,873	7,852	288,241	3,887	177,868	1,750	138,359	1,090	49,621	1,220	1,654
August	6,799	8,077	283,974	3,997	172,217	1,793	156,307	1,102	52,914	1,191	1,666
September	6,822	7,970	278,415	4,070	177,403	1,769	170,423	1,126	57,937	1,045	1,475
Week Ended:											
10-11-57	6,729	7,744	283,314	3,909	177,948	1,772	172,683	1,045	59,041	1,058	1,466
10-12-56	6,993	7,498	279,548	3,772	174,062	1,772	153,199	1,099	47,349	954	1,403

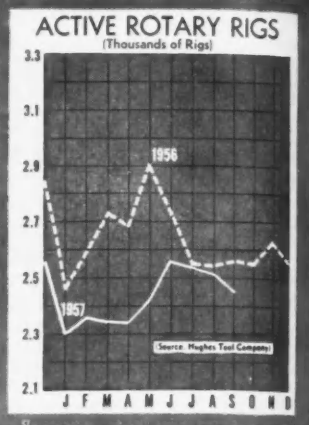
Source: Data for last two months from API; prior monthly data from Bureau of Mines.

Drilling Activities . . .









September Drilling Holds Pace, Improving Comparison With '56

By Cecil W. Smith
WORLD OIL Staff

SEPTEMBER'S WELLS totaled 4600 to drop 170 from the 4770 completed in August, but on a daily basis there was little difference in the two records. August's average amounted to 154 wells daily, while September's averaged a little better than 153 per day.

This pace helped the year's record to make some gain on last year's activity. At the end of August, this year's wells trailed the 1956 total by 9.5 percent, but at the close of September this margin had been lowered to 8.9 percent, and the difference should continue to narrow.

At the end of September, new wells drilled totaled 40,291. A year earlier, the total had been 44,220 new wells, and that shows that 3929 fewer wells, or 8.9 percent, have been drilled in the first nine months of this year. The last three months should see this margin of difference shrink some more, not from greatly increased activity, but because of the slackening that took place in the final months of 1956 due to the pipe shortage.

A better measure of drilling activity than the number of wells is the amount of footage drilled. In this comparison, the 1957 campaign does not show as badly as it does from a wells-drilled standpoint. While wells drilled trail the 1956 operations by 8.9 percent, footage drilled in these wells trail last year's by only 7.1 percent. The month of September saw this margin drop one percent, as total footage was 8.1 percent behind 1956 at the end of August.

This year's wells have been drilled to an average depth of 4126 feet, while a year earlier the average had been 4047. Thus, accounting for the difference in the wells and footage comparisons with 1956 records.

Of the 34 states in which some drilling activity has occurred this year, 22 saw declines compared with 1956, 11 enjoyed gains, and one broke even.

The leading state, Texas, saw 3.2 percent fewer wells drilled this year, but the state's share of the nation's total wells rose from 38.8 percent in 1956 to 41.2 percent so far in 1957. The Number 2 drilling state, Oklahoma, dropped 29.6 percent in the number of wells, and now accounts for 10.5 percent of the U. S. total instead of the 13.6 percent it donated a year earlier.

Although Kansas' wells dropped 10.7 percent from last year, the state still holds third place in the nation. Fourth place has been taken over from Illinois by Louisiana, and this state is the only one of the top five that has been able to muster an increase this year. New wells in Louisiana gained 1.2 percent over 1956. Currently fifth-ranked Illinois' operations declined 31.7 percent.

Summary of U. S. Drilling Activity

ITEM	Sept., 1957	Aug., 1957	NINE MONTHS January-September 1957	1956	Percent Diff.
New Wells Completed:					
Oil	2,334	2,436	21,049	23,447	— 10.2
Distillate	69	77	539	437	+ 23.3
Gas	341	337	2,782	2,966	— 6.2
Service	94	89	792	716	+ 10.6
Dry	1,762	1,831	15,129	16,654	— 9.2
Total Wells	4,600	4,770	40,291	44,220	— 8.9
Footage Drilled (Mls. of Feet)	19.2	19.2	166.3	179.0	— 7.1

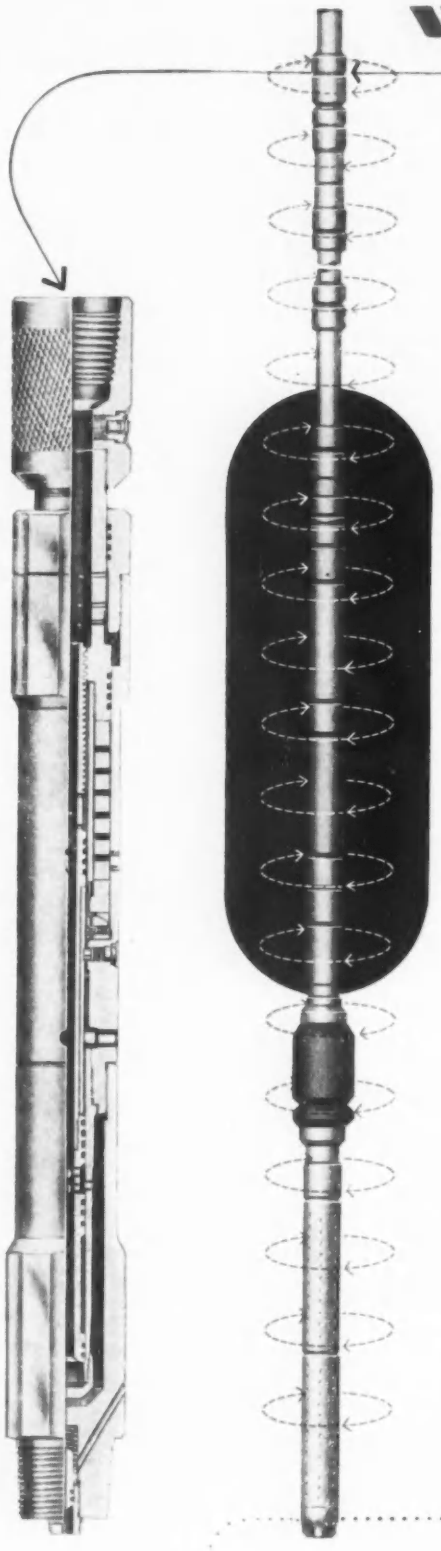
Summary of U. S. Wildcat Drilling

ITEM	Sept., 1957	Aug., 1957	NINE MONTHS January-September 1957	1956	Percent Diff.
New Field Discoveries:					
Oil	88	82	642	818	— 21.5
Distillate	9	13	92	86	+ 7.0
Gas	22	21	172	176	— 2.3
Total Discoveries	119	116	906	1,080	— 16.1
Dry Wildcats	890	888	7,672	8,339	— 8.0
Total Wildcats	1,009	1,004	8,578	9,419	— 8.9
Percent Productive	11.8	11.6	10.6	11.5	.....
Percent Dry	88.2	88.4	89.4	88.5	.....

U. S. Drilling Activity in September and First Nine Months, 1957-1956

STATE or DISTRICT	TOTAL NEW WELLS COMPLETED AND FOOTAGE DRILLED: DETAILS FOR SEPTEMBER, 1957 — Oil	Dist.	Gas	Dry	Service Wells	TOTAL NEW WELLS — Sept., 1957	Aug., 1957	Sept., 1956	Total Footage Sept., 1957	DETAILS FOR JANUARY-SEPTEMBER — NEW WELLS — 1957	1956	Percent Diff.	FOOTAGE — 1957	1956	WILDCAT DRILLING IN SEPTEMBER AND FIRST NINE MONTHS, 1957-1956 — DETAILS FOR SEPT., 1957 — Oil	Dist.	Gas	Dry	Total Wildcats	DETAILS FOR JANUARY-SEPTEMBER — Oil	Dist.	Gas	Dry	TOTAL WILDCATS — 1957	1956	DRILLING RIGS IN OPERATION — Sept. 30, 1957	Aug. 31, 1957	Sept. 30, 1956
Alabama	3	....	....	1	....	4	4	5	46,871	75	68	+ 10.3	660,698	571,480	....	....	....	1	1	....	....	1	26	27	20	9	8	11
Arizona	....	....	....	....	....	....	1	....	....	2	7	— 71.4	4,505	22,048	....	....	....	....	....	....	....	....	2	2	7	4	5	1
Arkansas	58	....	....	36	....	94	123	110	293,497	833	708	+ 17.7	2,499,764	2,157,335	1	....	....	21	22	9	....	....	123	132	112	64	69	61
California	145	....	3	51	....	199	182	178	926,314	1,646	1,623	+ 1.4	7,105,715	7,609,962	1	....	....	30	31	7	....	3	264	274	214	184	178	196
Colorado	18	....	5	50	....	73	65	107	363,271	606	955	— 36.6	3,139,173	4,932,085	2	....	2	35	39	17	1	10	337	365	496	66	66	81
Florida	....	....	....	....	....	....	....	1	....	8	9	— 11.1	57,082	50,005	....	....	....	....	....	....	....	....	8	8	9	....	....	5
Georgia	....	....	....	....	....	....	....	....	....	3	5	— 40.0	18,955	22,008	....	....	....	....	....	....	....	....	3	3	5	....	....	1
Idaho	....	....	....	....	....	....	....	....	....	1	1	....	3,947	4,528	....	....	....	....	....	....	....	....	1	1	1	....	....	2
Illinois	118	....	2	130	....	250	294	398	605,319	1,955	2,864	— 31.7	4,465,341	6,6645,963	2	....	....	57	59	11	....	1	550	562	749	233	258	264
Indiana	16	....	1	34	....	51	80	65	87,363	489	504	— 3.0	798,314	877,887	....	....	....	17	17	1	....	....	138	139	125	101	120	107
Kansas	160	....	17	169	8	354	367	392	1,239,596	3,122	3,498	— 10.7	11,084,052	12,336,062	12	....	3	69	84	87	....	22	647	756	936	599	563	510
Kentucky	72	....	12	95	3	182	191	173	252,661	1,293	1,414	— 8.6	1,902,262	2,094,933	5	....	....	9	14	17	....	....	77	94	116	147	139	122
Louisiana	188	28	40	130	....	386	324	341	2,958,349	2,814	2,780	+ 1.2	22,340,152	20,506,530	6	4	....	53	63	27	31	10	386	454	498	444	427	390
North Louisiana	88	3	17	47	....	155	144	172	556,615	1,053	1,202	— 12.4	3,841,291	4,371,311	2	....	....	17	19	7	2	3	120	132	174	86	83	71
South Louisiana	100	25	23	83	....	231	180	169	2,401,734	1,761	1,578	+ 11.6	18,498,861	16,135,219	4	4	....	36	44	20	29	7	266	322	324	358	344	319
* Gulf of Mexico	31	3	10	13	....	57	34	25	578,984	494	320	+ 54.4	4,665,903	3,007,956	....	1	....	3	4	7	5	3	40	55	53	81	95	47
Maryland	....	....	....	....	....	....	....	....	....	....	4	—100.0	....	30,716	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Michigan	22	....	2	15	....	39	41	32	113,340	300	336	— 10.7	864,186	959,925	....	....	....	9	9	8	....	1	94	103	123	79	75	65
Mississippi	12	3	1	25	....	41	41	42	298,428	291	328	— 11.3	2,100,420	2,353,016	1	....	....	16	17	10	1	....	141	152	148	53	49	37
Missouri	....	....	....	5	....	5	1	....	1,941	9	21	— 57.2	6,110	23,811	....	....	....	5	5	....	....	....	9	9	15	....	....	3
Montana	18	....	1	17	....	36	41	60	168,221	299	374	— 20.1	1,503,733	1,854,836	....	....	1	14	15	2	....	3	99	104	145	62	47	63
Nebraska	24	....	....	61	....	85	90	63	504,871	682	7231	— 6.7	4,033,736	4,230,275	4	....	....	38	42	29	....	1	322	352	351	34	40	26
Nevada	....	....	....	....	....	....	1	....	....	4	5	— 20.0	10,568	28,571	....	....	....	....	....	....	....	....	4	4	3	1	2	4
New Mexico	108	1	57	41	....	207	159	143	1,091,521	1,673	1,486	+ 12.6	7,833,224	6,671,118	2	....	1	18	21	34	2	7	182	225	208	174	192	188
New York	21	....	1	2	24	48	48	50	69,900	375	346	+ 8.4	603,800	484,850	....	....	....	....	....	....	....	....	....	....	....	60	58	70
North Dakota	13	....	....	13	....	26	18	24	173,873	197	209	— 5.8	1,376,421	1,559,731	2	....	....	10	12	11	....	....	78	89	65	45	40	26
Ohio	56	....	27	26	....	109	79	75	276,169	763	772	— 1.2	1,838,568	1,866,087	1	....	....	1	2	1	....	....	7	8	3	195	208	222
Oklahoma	196	....	18	142	8	364	519	570	1,308,453	4,244	6,025	— 29.6	15,379,691	21,546,697	5	....	1	46	52	50	7	18	419	494	635	603	606	577
Oregon	....	....	....	....	....	....	....	....	....	2	1	+100.0	10,592	12,880	....	....	....	....	....	....	....	....	2	2	1	1	1	....
Pennsylvania	35	....	19	5	34	93	96	95	203,229	728	658	+ 12.2	1,962,970	1,794,112	....	....	3	2	5	....	....	25	10	35	....	185	189	175
South Dakota	....	....	....	4	....	4	3	2	8,819	34	16	+112.5	122,344	58,965	....	....	....	4	4	....	....	....	32	32	16	2	1	4
Texas	998	37	89	653	17	1,794	1,808	1,716	7,551,930	16,599	17,152	— 3.2	69,725,728	72,619,589	41	5	9	401	456	298	50	56	3,460	3,864	4,164	1,184	1,267	1,294
Dist. 1: South Central	55	3	18	48	....	124	87	146	349,973	1,008	1,565	— 35.6	2,581,884	4,078,570	1	1	1	36	39	15	2	2	270	289	412	32	52	39
Dist. 2: Middle Gulf	14	3	14	33	....	64	78	71	358,259	589	631	— 6.7	3,629,171	3,904,431	1	....	....	20	21	5	11	10	174	200	213	32	28	40
Dist. 3: Upper Gulf	50	10	12	58	....	130	159	152	828,409	1,292	1,362	— 5.1	8,559,291	9,231,826	....	1	1	33	35	20	9	2	315	346	369	101	114	148
* Gulf of Mexico	....	....	....	....	....	....	1	2	....	7	9	— 22.2	52,372	96,660	....	....	....	....	....	1	....	....	2	3	6	2	....	5
Dist. 4: Lower Gulf-S.W.	35	11	10	63	....	119	145	111	653,100	1,103	1,106	— 0.3	5,811,208	5,786,976	2	....	1	38	41	14	7	3	317	341	385	71	83	72
* Gulf of Mexico	1	....	1	1	....	3	4	1	20,118	19	10	+ 90.0	181,268	89,013	....	....	....	....	....	....	....	....	2	2	1	2	2	3
Dist. 5: East Central	2	1	....	18	....	21	12	20	100,791	129	189	— 31.8	584,652	630,106	....	....	....	13	13	1	1	1	85	88	104	10	18	11
Dist. 6: Northeast	59	6	5	26	....	96	92	90	510,544	829	689	+ 20.3	4,478,267	3,673,821	3	....	....	19	22	7	2	4	179	192	177	71	63	82
Dist. 7-B: North Central	103	....	3	120	1	227	220	246	719,937	2,054	2,368	— 13.3	6,902,634	8,377,455	15	....	....	82	97	77	....	7	678	762	898	98	103	120
Dist. 7-C: West Central	65	1	2	35	....	103	84	96	459,719	903	1,003	— 10.0	4,082,578	4,561,064	2	1	....	21	24	32	1	6	220	259	258	79	85	122
Dist. 8: West	327	....	5	57	6	395	431	285	1,947,963	3,794	3,230	+ 17.5	18,615,225	16,634,046	9	....	1	37	47	66	1	5	334	406	400	360	371	327
Dist. 9: North	210	1	3	172	10	396	362	384	1,096,501	3,787	3,929	— 3.6	10,050,968	11,468,151	4	1	....	90	95	51	2	5	814	872	837	210	227	230
Dist. 10: Panhandle	78	1	17	23	....	119	138	115	526,734	1,111	1,080	+ 2.9	4,429,850	4,273,143	4	1	5	12	22	10	14	11	74	109	111	120	123	103
Utah	24	....	4	18	....	46	20	8	227,513	178	105	+ 69.5	980,798	498,586	2	....	1	16	19	9	....	3	67	79	68	79	75	31
Washington	....	....	....	....	....	....	1	....	....	4	1	+300.0	20,459	7,493	....	....	....	....	....	....	....	....	3	3	1	1	1	....
West Virginia	14	....	39	11	....	64	77	63	188,366	483	530	— 8.9	1,317,028	1,420,674	....	....	1	1	2	....	....	7	9	16	....	175	170	190
Wyoming	15	....	3	28	....	46	96	94	200,534	579	684	— 15.4	2,542,054	3,086,315	1	....	....	17	18	14	....	4	172	190	185	103	91	101
Total United States	2,334	69	341	1,762	94	4,600	4,770	4,807	19,160,349	40,291	44,220	— 8.9	166,252,190	178,959,073	88	9	22	890	1,009	642	92	172	7,672	8,578	9,419	4,887	4,945	4,828
Total Western Canada	165	....	21	55	5	246	319	238	1,086,759	2,307	2,172	+ 6.2	10,706,260	10,224,375	....	....	....	....	....	....	....	....	....	....	....	201	231	226

* Gulf of Mexico wells are included in their respective distict totals.



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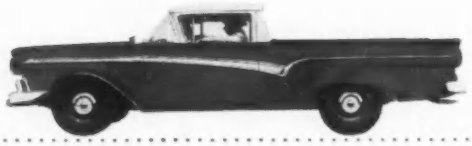

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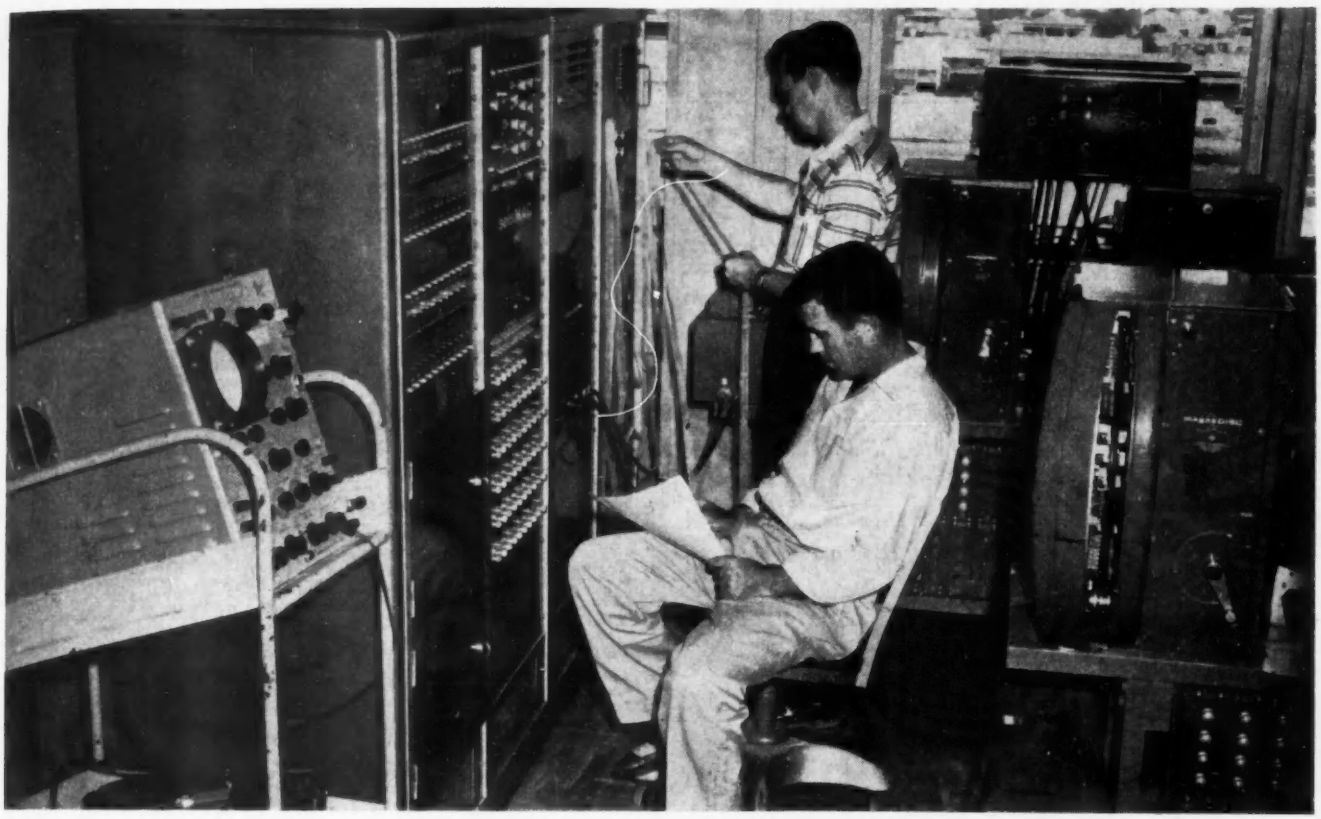

Today's seismic data processing equipment for magnetically recorded data presents information previously lost or obscured in earlier seismic recordings and interpretation techniques.

Magnetic recording has brought a big step forward in geophysical techniques, but . . .

Seismic Data Processing Is a New Exploration Tool

It makes full use of all recorded information, preserving data permanently for subsequent studies and interpretation. Information previously undetected now can be used to reveal stratigraphic traps, lithologic changes, faulting, and changes in section thickness.

By K. E. Burg, Geophysical Service Incorporated, Dallas

In Less than five years after its introduction to the geophysical exploration industry on a general scale, magnetic recording of seismic data has become an established refinement of the seismic technique. Magnetic recording is accepted. It is accepted to the extent that it appears certain the near future will see the magnetic recording of most, if not all, seismic data.

The advantages of seismic magnetic recording have been discussed at considerable length, and they have been the subject of some debate as to whether their extra cost is always justified in terms of increased oil-finding capacity. It is the purpose of this article to point out that seismic magnetic recording, whatever its advantages, should not be considered a complete technique or an end in itself. Rather, it is a means to an end which is potentially the most effective tool yet given the geophysicist and the geologist to increase their joint capacities for finding oil.

This valuable new exploration tool is seismic data processing.

Evolution of Processing. The development of magnetic recording, with its capacities for storage of seismic information in fully reproducible form, had to precede the development of data processing. It was also necessary for the geophysical exploration industry to have the right equipment and to produce processed data for some time before the full potentialities of data processing could become evident.

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Without too much doubt, it can be said that not many months ago oil companies and geophysical companies alike looked on data processing as a way to "pretty up" seismic information, as a convenient way to get a look at a whole sweep of profile line without spreading individual records across the floor of an office.

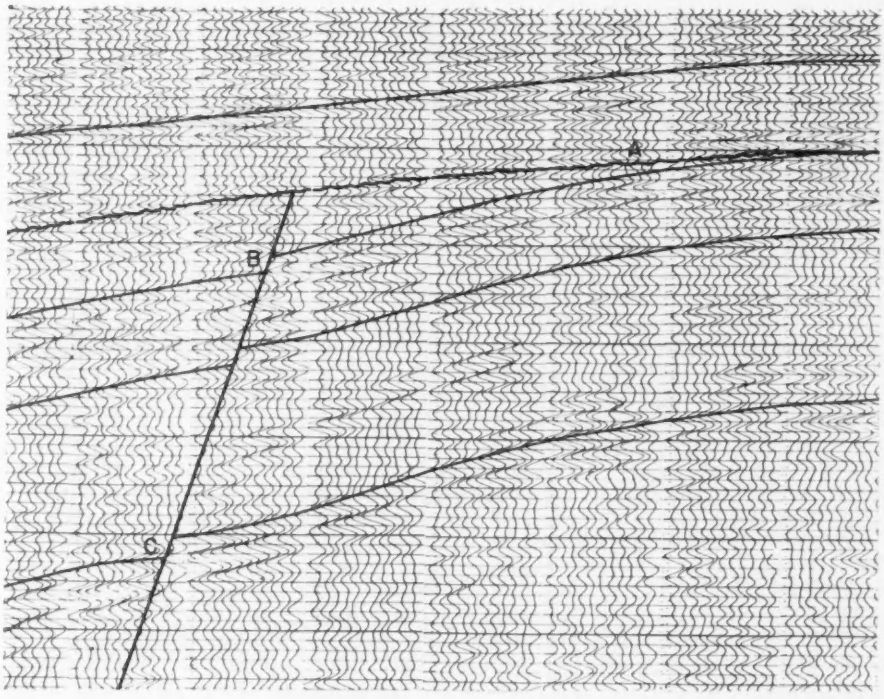
These were not necessarily minor considerations, because it is important to present seismic information, particularly when it is required for management decisions, in clean-cut and accessible form. But it is much more important to make full use of the information that is recorded with each seismic shot fired. Few people have figured a "cost per profile" in terms of the information transferred from seismogram to cross section to map, where it was finally used for prospect evaluation. Figured on a much-used "end and center trace" method of hand-plotting seismic data, such cost could better be stated in terms of information not used.

Seismic data processing, on the other hand, makes full use of all the recorded information and presents it in a form designed to preserve the evidence on which successive judgments may be based in interpretation. These are the characteristics which make data processing more than a refinement in seismic technique and interpretive quality control. They are the characteristics which make data processing a new tool for exploration, since they, as much as the act of detonating a charge in a shot hole and recording the resulting ground movement, bring to light information that previously was hidden.

It is this previously undetected information that the geologist and the geophysicist must have to find the oil that has its accumulation governed by stratigraphic traps, by lithologic changes, by undetected faulting, and by changes in section thickness.

Advantages. The new tool of data processing already is known to be capable of yielding a number of highly important accomplishments. Among them are the following:

• With data processing it is possible to prepare seismic data so that hitherto unrecognized details of the subsurface are represented. We can now use these small bits of seismic data which may be indicative of all-important anomalous subsurface conditions which control the accumulation of oil.



Processed record section shows subsurface in new detail. Note unconformity (A), change in amplitude characteristics indicative of faulting (B), and sudden change in dip related to faulting (C). Hand-plotted cross-sections do not provide this diagnostic detail.

• Data recorded magnetically with modern low-distortion, high-dynamic-range instruments can now be processed in various manners to enhance or to emphasize the anomalous subsurface conditions.

• Previously confusing characteristics of seismic data, such as the highly variable and sometimes erratic weathering and elevation (near-surface) travel time distortions and the misleading increase of travel time with increase of shot-to-seismometer distance (normal moveout), may be eliminated. Each seismic trace then represents a true subsurface condition rather than a complex admixture of near-surface and subsurface variables.

• Minute phase changes in magnetically recorded data, which are indicative of a sudden change in dip due to faulting or to diffractions from a fault interface, are preserved and enhanced through data processing and made more recognizable.

• Amplitude characteristics of magnetically recorded data are preserved through processing techniques and presented for full use in interpretation from the integrated record section. These characteristics are indicators of faulting, a change in lithology, or a change in thickness of the subsurface layer. Present instruments allow recording with a minimum of amplitude and phase distortion. But in hand-picking paper seismograms and plotting paper cross-sections, amplitude characteristics are usually represented only through such grading symbols as "G", "F", or "P" for good, fair, or poor data. In non-reproducible seismic recording, AGC and filter distortions effectively destroy these important amplitude characteristics.

• The geophysicist working with the results of seismic data processing is himself up-graded. He becomes much more effective as an oil finder when working with carefully prepared record sections, because he is able to spend his time more effectively in data analysis. When he works with conventional, unprocessed paper records, a very large portion of his time is spent in picking and timing a mass of reflections, which are then laboriously transferred by hand to a plotted cross-section. A disproportionate amount of his time is used in routine tasks. But the geophysicist working with processed record sections spends his time in a detailed study of the complete package of data. He is able to make full use of his training and skill.

Good Original Data Required. It is significant to point out that the new tool of seismic data processing is of value according to the quality of the

Continued on Page 82

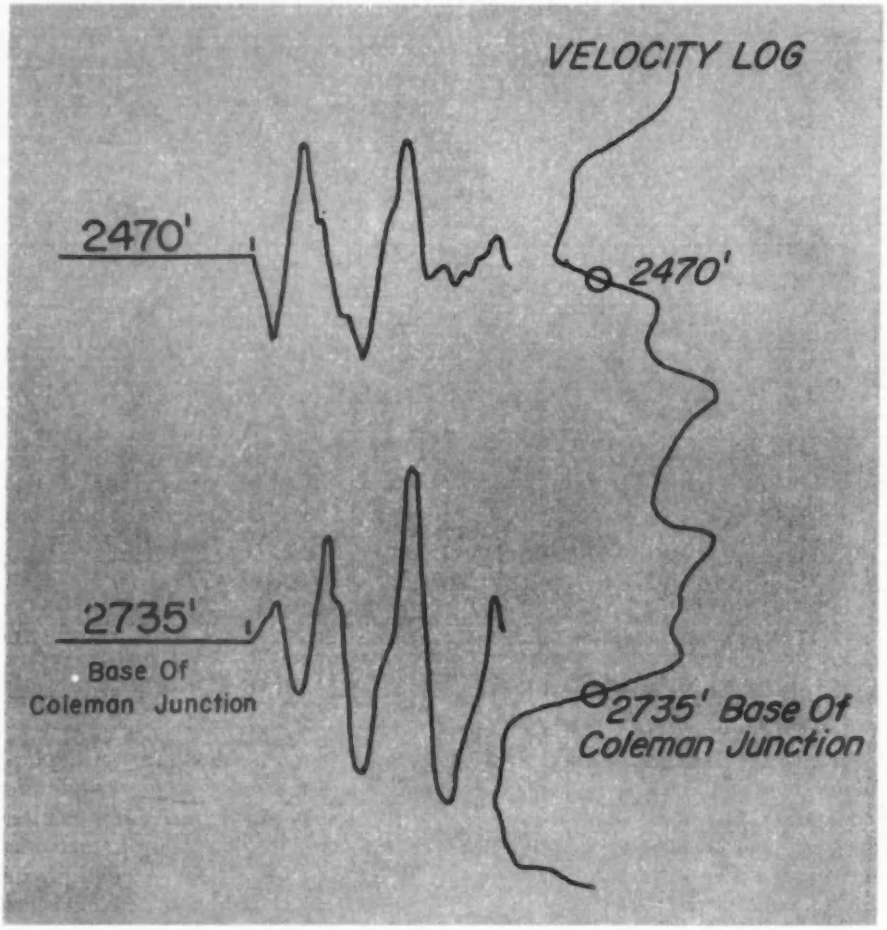


FIGURE 1—One of the best examples of reversed breaks comes from placing the geophone at the base of the Coleman Junction along the eastern part of the Permian Basin.

Velocity Surveys Aid In Seismic Interpretation

Continuous velocity logger provides reliable information for correctly interpreting seismic data. Acoustic logging tool also aids in geological correlation and in study of formation porosities and fluid saturation.

By C. H. Thurber, Empire Geophysical, Inc., Fort Worth

VELOCITY SURVEYS are designed to help the seismologist with his interpretation. Velocity information may confirm or disprove an interpretation of seismic data. It may identify the zone of reflection energy. It may tie geology to seismic reflections.

The basic or conventional method of making a velocity survey is the well geophone survey, the technique of shooting small charges of explosives in shallow holes and measuring the travel time to a geophone placed in the well.

There are many arrangements of the shot points around the well with the horizontal distance varying from 100 to 2000 feet. Field conditions generally control the setup. But some companies have their own standards. Often the setup is placed so that the opposite shot point groups will be on strike, and often at right angles to the strike.

The problem of running a well shooting program is one of getting the job done now, since there is no chance to re-shoot it tomorrow. Once the survey is started it should be completed. Getting to the well and coordination with other services at the right time is getting better all the time. Communications and cooperation between all parties have helped to make it possible to run velocity surveys at much lower cost. Less shutdown time and standby expense is the result.

Records obtained in the field should obtain the following information:

- Three amplitudes of the well geophone.
- Shot uphole time.
- Reference geophone time.
- Time break.

The well geophone is placed on three different traces at different amplitudes, in order to study the character of the breaks, and thus properly pick the records.

The reference geophone may be used to identify the side the shots were fired from and aid in determining the reliability of the shot initiation.

It has been noticed that the placement of the geophone in the well has more to do with the character of the breaks that are obtained on the record than any other factor. It is presumed that enough energy is used to have a signal-to-noise ratio that is satisfactory. At this point it is appropriate to show some of the interesting character observed in the first breaks during well shooting. But first it would be favorable to think of the conditions under which the records are obtained. The geophone is suspended in the well on a long wire line. And unless the well is dry the geophone is in fluid and moves as the result of the fluid coupled movement of the sediments adjacent to the geophone.

The normal break is down and oscillatory with an increase in amplitude for about four cycles and with a persistence of energy. We look for the persistence of energy to differentiate energy from noise. This would more nearly describe the desired break

than the normal. (See top example, Figure 1.)

Reversed breaks are often encountered and are the results of conditions that are very real in the well. They are repeatable and can be used if understood. The following observations from more than 4 million feet of velocity surveys have been made. However, most of these observations were made in the field, and often it was possible to study the records and to take appropriate measures.

1. Records are repeatable at the same depth.
2. Changing depths changed the hole conditions adjacent to the geophone.
3. Of the many reversed breaks studied the geophone has always been at the contact between a high velocity media *above* a low velocity media.
4. No reversal has been noted when the nature of the beds could be determined, wherein the low velocity formation was above the high velocity formation.

It is concluded that the fluid movement is in the up direction on the reversed breaks and is the result of a greater formation deformation in the low velocity media than in the high velocity media. This being a squeezing effect on the hole.

One of the best examples of reversed breaks comes from placing the geophone at the base of the Coleman Junction along the eastern part of the Permian Basin (Figure 1).

An important common feature of velocity surveys is the difference in time noted from shots at the same level in the well but from opposite sides of the well. These differences should be considered as times available for refraction studies of the area. Factors to be considered, when these time differences are observed, are:

1. Horizontal distance different across the well.	1. The time difference becomes smaller with increase in well geophone depth.
2. Vertical surveying error.	2. The time difference is constant with depth since the error is in the correction to plane.
3. When the well drifts from vertical.	3. Both the depth and diagonal distances are changed, effecting the difference in time. It is believed that the drift may reflect some geology also.
4. Geologic feature of faulting and dip.	4. These may account for the greatest number of time differences across a well.
5. Sub-shot velocity differences.	5. Time differences are constant with depth.

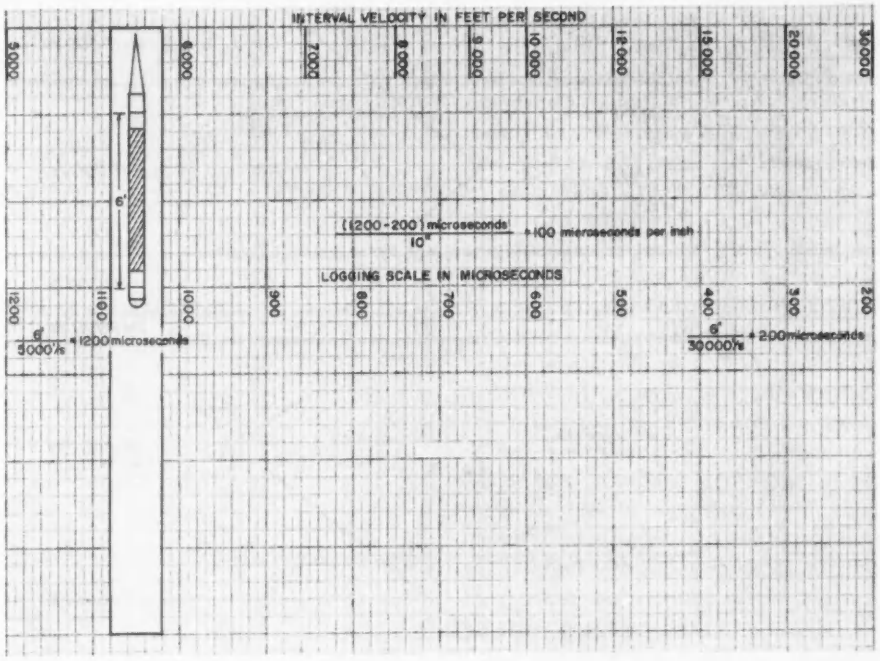


FIGURE 2—In using the acoustic logging tool, the instruments are made to measure the time from the transmitted pulse to the received signal and keep a constant plot of this time on a convenient chart as the tool is moved in the bore hole.

Changes in character of records with changes in depth are to be expected, due to changes in hole condition and different arrangements of sediments with respect to the well geophone. Occasionally an actual delay in high energy is seen in the character of the breaks some time after low energy first breaks. Generally, character of well geophone breaks show similarity within reasonable depth differences in any one well.

Acoustic Logging Tool. Within the last few years the acoustic logging tool has become the most widely accepted means for gathering velocity data. Many people have asked: "How do you read a log, what do the scales mean, and where does all this information come from?" The purpose here will be to supplement the ad-

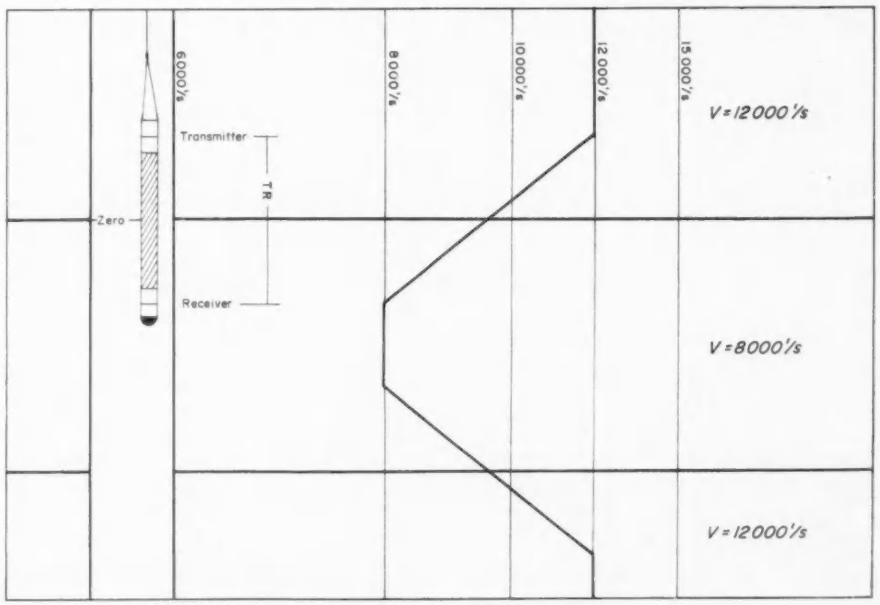


FIGURE 3—As the logging tool is passed through a formation of constant velocity the time measured will be constant. The center of the transmitter-to-receiver spacing is used as the zero point of the logging tool.

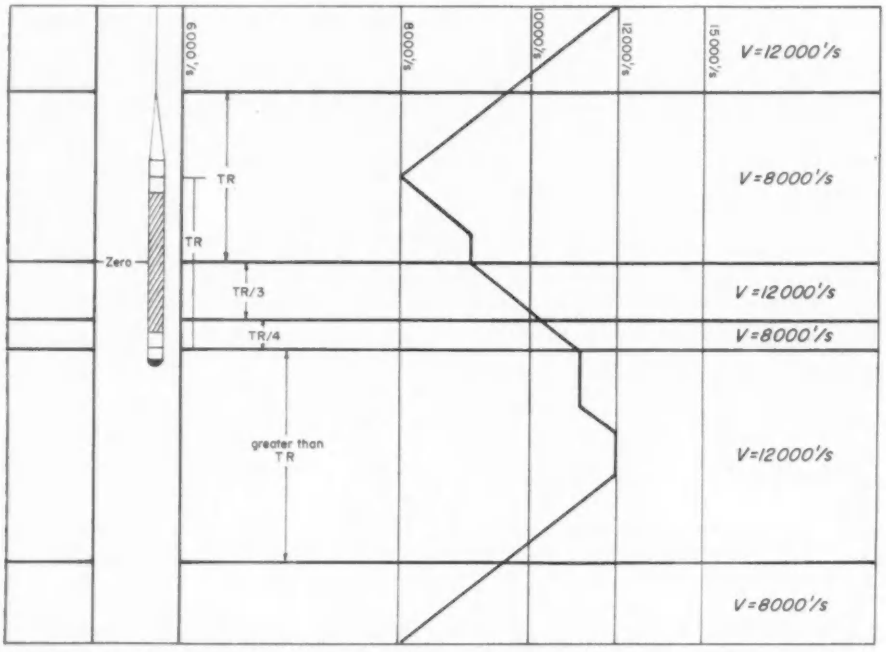


FIGURE 4—Illustrated here are conditions wherein the velocity zones are thinner than the tool length. Logs for any other real condition may be graphically shown.

vanced papers given on the logger by a simple discussion of some of the basic facts.

The logger with which the writer is best acquainted is the Magnolia logger described by G. C. Summers and R. A. Broding in the July, 1952, issue of *Geophysics*.

The downhole tool has a transmitter-to-receiver spacing of approximately six feet. (Actually nearer 5.8 feet.) Mud and water velocities are of the order of 5000′ per second and the highest range of velocities expected to be encountered by the tool is less than 30,000′/s. The instruments are made to measure the *time* from the *transmitted pulse to the received signal* and keep a constant plot of this *time* on a convenient chart as the tool is moved in the bore hole (Figure 2).

If the tool length is divided by the velocity limits we expect to encounter we will then have the time limits that it is necessary to measure.

Therefore:

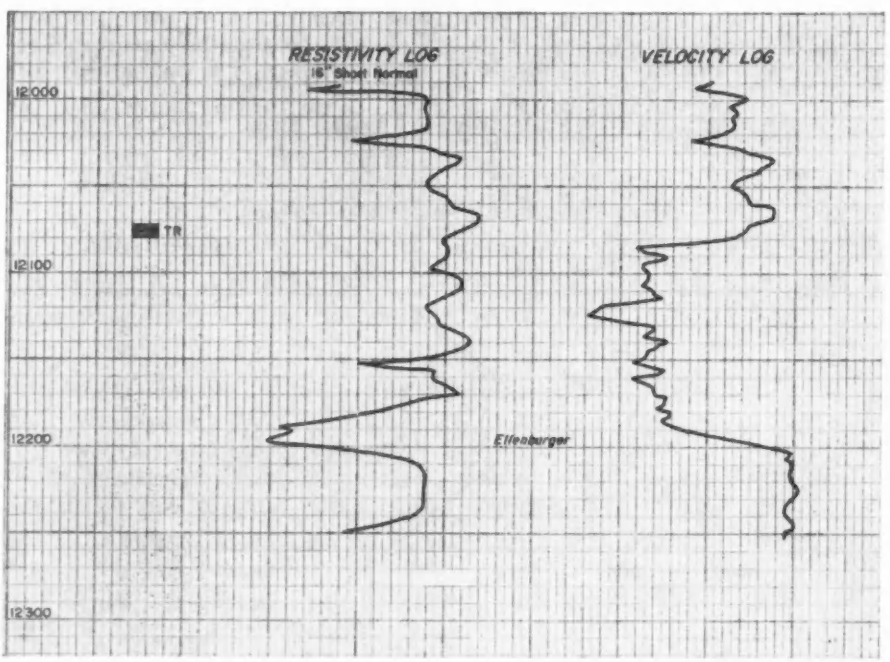


FIGURE 5—Logs as actually made. On right is the time log or velocity log. Tool length is shown on left as T-R. For comparison the short-normal that may be expected also is shown.

$$\text{for } 5000'/s = V,\ T = \frac{d}{v} = \frac{6'}{5000'/s}$$

$$= 0.0012 \text{ seconds}$$

$$= 1200 \text{ microseconds}$$

$$\text{for } 30{,}000'/s = V,\ T = \frac{d}{v} = \frac{6'}{30{,}000'/s}$$

$$= 0.002 \text{ seconds}$$

$$= 200 \text{ microseconds}$$

Microseconds. When looking at a log in microseconds, one must review the general arithmetic to see what constitutes a microsecond. As a measurement in time, a microsecond may be measured as follows:

one second = 1.000000 second

one microsecond = 0.000001 second

For a six-foot transmitter-to-receiver spacing the following tabulations of time vs. velocities are shown:

u s		
200	=	30,000′/s
300	=	20,000′/s
400	=	15,000′/s
500	=	12,000′/s
600	=	10,000′/s
667	=	9,000′/s
750	=	8,000′/s
857	=	7,000′/s
1000	=	6,000′/s
1200	=	5,000′/s

A convenient chart needs the time limits of 200 microseconds to 1200 microseconds. It requires 1000 microseconds for a full 10″ scale reading. Each inch representing 100 microseconds. This is a very handy scale for logging, and adjustments for any other tool length may readily be made.

In order to determine the velocity scale that fits the time scale, it is only necessary to divide the velocity into the spacing of 6′ and plot the point as a velocity. Such as 6′ divided by 10,000′/s gives a time of 600 microseconds and shows where that velocity may be plotted on the calibrated time scale. The velocity scale used is shown plotted in Figure 2.

It is now easy to note that as the logging tool is passed through a formation of constant velocity the time measured will be constant. The center of the transmitter-to-receiver spacing is used as the zero point of the logging tool (Figure 3).

The logs are made continuous by repeating the readings between 10 to 20 times per second. This is equivalent to readings every one to two inches when the tool is moving at a rate of 6000′/hr. (20 inches/second). There are, therefore, 36 to 72 samples per tool length as the tool is moved through the hole.

In the examples shown two velocity

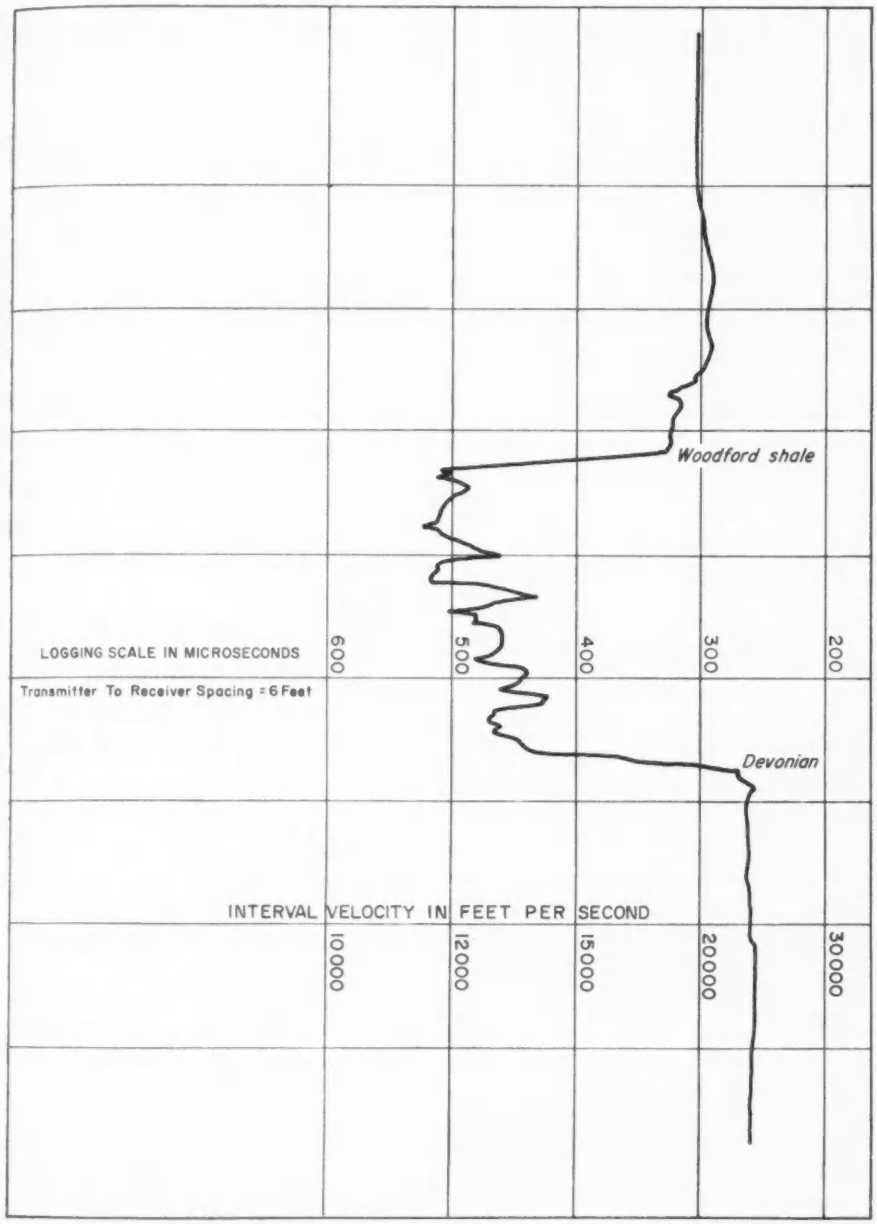


FIGURE 6—Illustration of a time log, showing what may be expected by logging the Woodford shale and the Devonian lime. The time of the signal travel through the shale is about 450 to 500 microseconds, and the Devonian is about 260 to 280 microseconds.

conditions are used: 8000′/s and 12,000′/s. It is the intention of these figures to show what happens to the log as the tool is passed through different zones. Figure 3 shows the condition of a velocity zone longer than the 6′ spacing. The tool will log the proportion of the zone included within the limits of the tool.

Figure 4 illustrates conditions wherein the velocity zones are thinner than the tool length. Logs for any other real condition may be graphically shown.

The next step is to illustrate the logs as they may be actually made (Figure 5). On the right is the time log or velocity log and the tool length is shown on the left as T-R, and just for comparison, the short-normal that may be expected is also shown.

Figure 6 is an illustration of a time log showing what may be expected by logging the Woodford shale and the Devonian lime. The time of the signal travel through the shale is about 450 to 500 microseconds and the Devonian is about 260 to 280 microseconds.

As the signal is traveling from the transmitter to the receiver, it travels through the mud to the formation, along the formation, out of the formation and through the mud to the receiver. The signal timed is the signal of the shortest travel time path. Since the total travel time is longer than the time of the travel time in the formation it is necessary to correct this time by removing part of it. This is first done by delaying the timing of the transmitted signal for an estimated time that experience has proven to be desirable in any area. In West Texas in general, 50 to 55 microseconds is used. On the Gulf Coast about 70 microseconds delay is used. With this correction already in the instruments it is not necessary to make as great a correction when the logs are calibrated to the seismic shots.

It would be well to briefly explain the reference to calibration by means of seismic shots. Seismic shots are taken to a standard geophone in the well at various depths. These shots provide the needed vertical travel time to tie the continuous velocity logging method to a reference at the surface. In the paragraph preceding, the method of delaying the timing signal was discussed. Since this is in itself an approximation, accurate velocity information can only be obtained when the tool is calibrated by means of the seismic shots.

A time integrator has been added to the logger in order to show the time that would be required for a seismic wave to travel through the formations being logged. When logging a formation of 15,000′/s the integrator pen will trace a curve with a slope of that velocity. The time scale for this curve is represented by 0.1 of a second for a full scale reading of 10″. The depth scale is that of the log (1500′ per full scale reading).

It can then be shown that as the logger is logging in a formation of 20,000′/s the time of the logging pen will be on 300 microseconds. If this is divided by the tool length of 6′ the rate would be 50 microseconds per foot of log. For each foot logged it is possible to add these microseconds per foot and arrive at the time required for a seismic wave to travel through the formations being logged. This can be shown for all velocity conditions as illustrated in Figure 7.

A model log of conditions that may be found in the field is illustrated (Figure 8). Three shot times are plotted at their depth in the well and the character of the shots is shown on the left. The calibrated time curve is shown with its relationship to the shots. A plot of the shot interval velocity is shown to indicate what often happens when the log is compared with conventional shooting. The

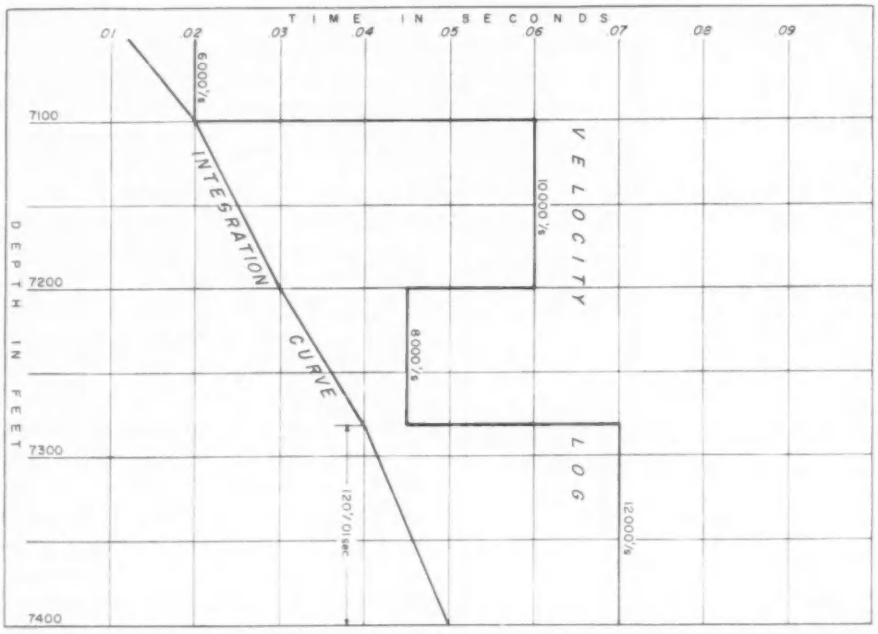


FIGURE 7—A time integrator has been added to the logger in order to show the time that would be required for a seismic wave to travel through the formations being logged. (See text on Page 81 for further explanation.)

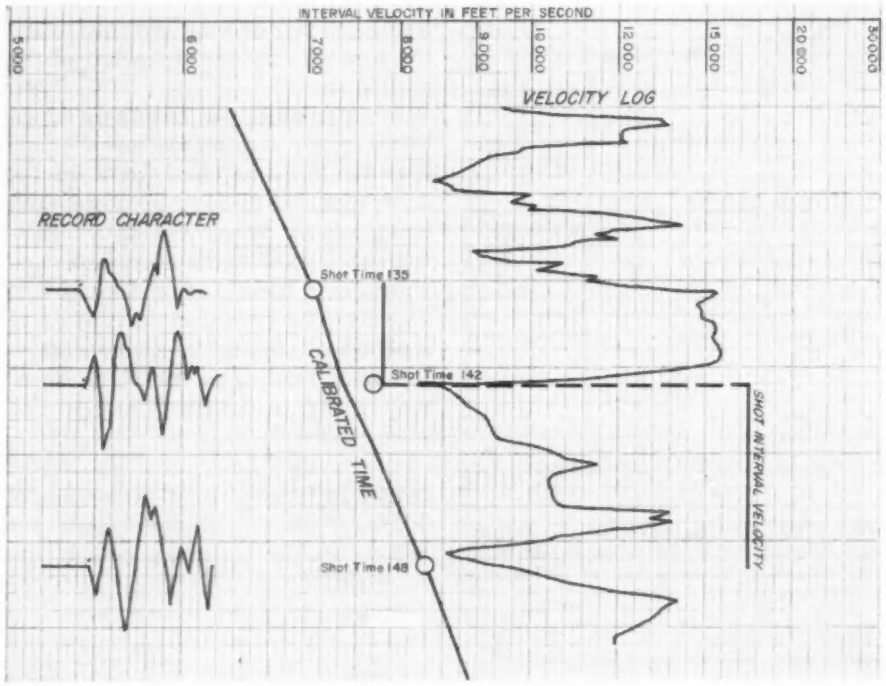


FIGURE 8—A model log of conditions that may be found in the field. (For explanation, see text in last paragraph on Page 81.)

velocity log is more nearly correct in this case than the shots, and in most other cases for short intervals. It is believed that it is not possible to time seismic records within the necessary accuracy to plot the correct interval velocity for distances less than 300′. As seen from some of the type breaks shown earlier in this article, it would be hard to make the picks. For long intervals it is believed that the shot interval time is good enough to calibrate the log.

While this discussion has dealt entirely with seismic velocity, it should not be interpreted that the acoustic logging tool or the continuous velocity logger is in effect only a geophysical tool. Actually, the continuous velocity log has proven to be not only an advanced method of obtaining reliable and detailed velocity information but has proven itself an excellent correlation tool for the geologist and an increasingly effective tool for the petroleum engineer or geologist studying formation porosities and fluid saturation problems. **—The End**

Seismic Data Processing

Continued from Page 77

information supplied it. The effectiveness of magnetic recording and data processing is dependent upon the quality of both the originally recorded data and the processing equipment and techniques.

Data processing will not build a good record out of a poor one. Compensations can be made for certain kinds of inadequacies in field recording techniques with careful data processing. But inadequate recording techniques become much more apparent when data are recorded magnetically. Failure to recognize these inadequacies and to take compensatory steps will result in a serious deterioration in the end product.

Data processing then forces the improvement of the entire data gathering and data handling procedure through the necessity for maximum quality control.

Such elements as these—improved quality control in seismic work, the truer portrayal of subsurface conditions, the preservation of data, and the enhancement of previously hidden information—make data processing pay its way in locating today's hard-to-find oil. There is a great deal yet to learn about milking seismic data of all the information it contains. But data processing is still developing, and it appears to point the way toward finding tomorrow's harder-to-find oil.

—The End

About the Author

Kenneth E. Burg is vice president in charge of geophysical engineering for Geophysical Service Inc., Dallas, Texas. He received his B.S. degree in electrical engineering from The University of Texas in 1926. He worked for the Geophysical Research Corporation in 1926-1930 and for Geophysical Service Inc., in 1930-1942. From 1942 to 1947 he was with Stanolind Oil and Gas Company, ultimately being placed in charge of all geophysical operations of that company. Burg rejoined Geophysical Service Inc., in January, 1947, and in 1950 was made vice president technical and placed in charge of equipment, field, and office techniques and research.

A New Seismic Dip Plotting Machine

Here is a new machine, fully automatic, which speeds the handling of conventional seismic data.

By J. A. Westphal
Sinclair Research Laboratories
Tulsa

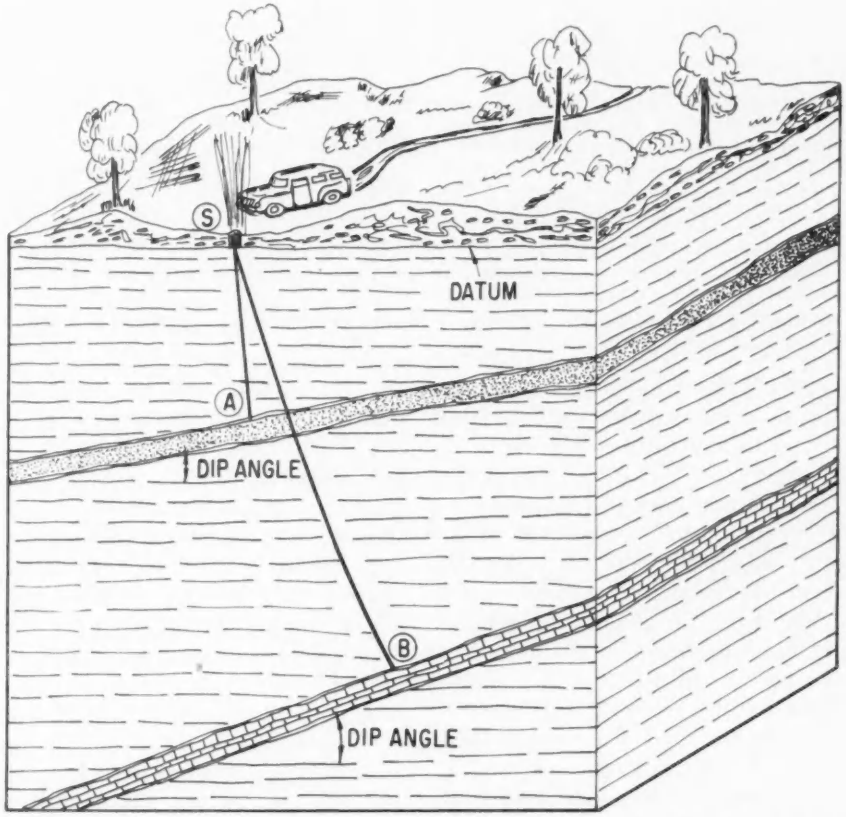


FIGURE 1—Diagrammatic presentation of effects of a shock wave due to exploding dynamite in a shot hole.

RECENTLY, SINCLAIR HAS developed a new plotting machine (patents pending) to facilitate the handling of seismic exploration data. This machine utilizes the seismic information directly from a seismogram and computes and plots the position of the reflection on a cross section without hand calculation or tabulation. The machine is fully automatic, plotting depth points at approximately ten times hand speed. Operating with a "linear increase of velocity with depth," velocity assumption, the machine plots the point in the subsurface from which the shockwave was reflected in two dimensions.

In Figure 1 a shock wave due to dynamite exploding in the shot hole at "S" travels downward toward "A" and is reflected upon itself back to "S" where it can be recorded by conventional seismic procedures. Another ray travels from "S" along a curved path down to "B" and back on itself to "S" where it also can be

FIGURE 2—Marking the "migrated" depth point on a "Servo Computer."

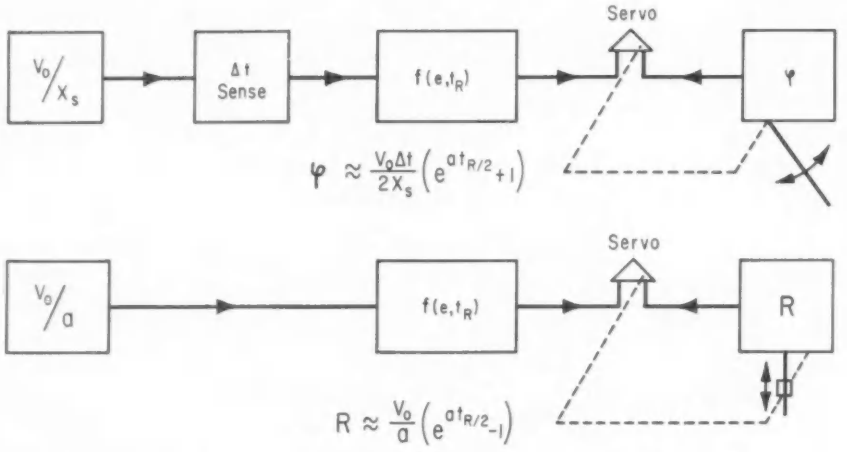


FIGURE 3——Block diagram showing steps taken by "Servo Computer" in finding the migrated depth point.

recorded. The computer locates the position of point "A" and of point "B" accurately up to a dip angle of 40 degrees.

The computation is done by a "servo computer" which obtains its input by mechanical to electrical conversion on a plotting table shown on Figure 2. The gentleman is scanning the seismogram and the lady is marking the "migrated" depth point. Changes in the velocity and acceleration factors used for computation can be made easily and quickly by adjustment of a cam and re-setting of two potentiometers. Changes in spread length and different record sizes are also easily handled. Indices are inscribed on the sensing table to take care of variations in paper speed in the original recording of the seismogram and to allow the easy insertion of weathering and elevation corrections.

Figure 3 illustrates in a block diagram the steps taken by the servo computer in finding the migrated depth point. The machine computes in polar coordinants; that is, the depth point is found by rotating an arm through some angle and measuring the distance downward along the arm. The upper part of Figure 3 illustrates the "machine equation" and the steps taken by the computer in finding the angle of the arm. The initial velocity, V_o, divided by the spread length, X_s, is entered electrically into the Δt converter where it is multiplied by the value of Δt. This value is fed to a device which computes the rest of the equation for the angle γ. The output of the computer is then compared by a servo mechanism with the physical position of the arm and the servo mechanism moves the arm until it is in the correct position. In the lower part of the figure, the machine equation and block diagram for the distance along the arm "R," is shown. The initial velocity is divided by the acceleration constant (a) and fed into the device which computes the rest of the equation. The output is compared by a servo mechanism with the position of the small block on the arm and the block is moved by the servo mechanism to the correct position. The depth point is thus located and can be marked on the section either by hand or by a mechanical printing device.

Referring to Figure 4, the arm and the small traveling block may be seen over standard cross section paper on which several dip segments have been plotted.

This machine was primarily developed to facilitate the handling of the large number of seismograms produced by the offshore exploration program of Sinclair. Although most of the original processing has been done, the machine will still have great utility in the review and recomputation of problem areas and areas of particular interest. Its great speed in handling data makes it practical for a geophysicist to operate the machine and "try" many events seen on the records to determine their validity. We have found that much data is plotted that would not be used if computed by hand. A better interpretation of the seismic information is therefore usually possible. Since the machine will easily handle cross sections of most any scale, the original cross sections may be used directly by the machine without the need for complete re-plotting. Although the machine only plots dips to 40 degrees, the uncertainty in the original data for dips of above 40 degrees makes such data of dubious quality. We believe that the plotter is a valuable addition to the tools available to those who find oil.

—The End

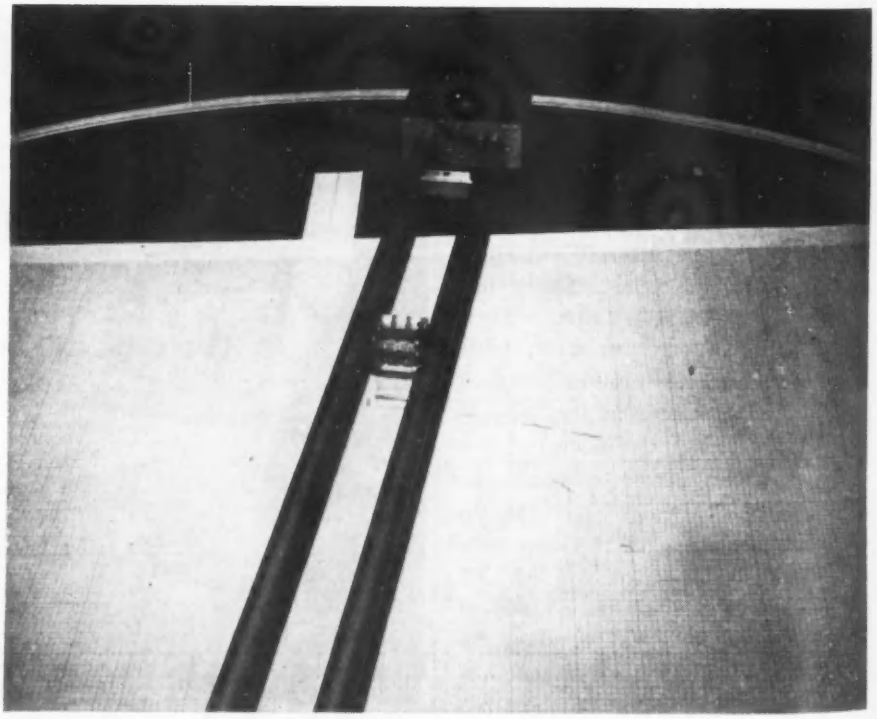


FIGURE 4—Arm and small travelling block over standard cross-section paper on which several dip segments have been plotted.

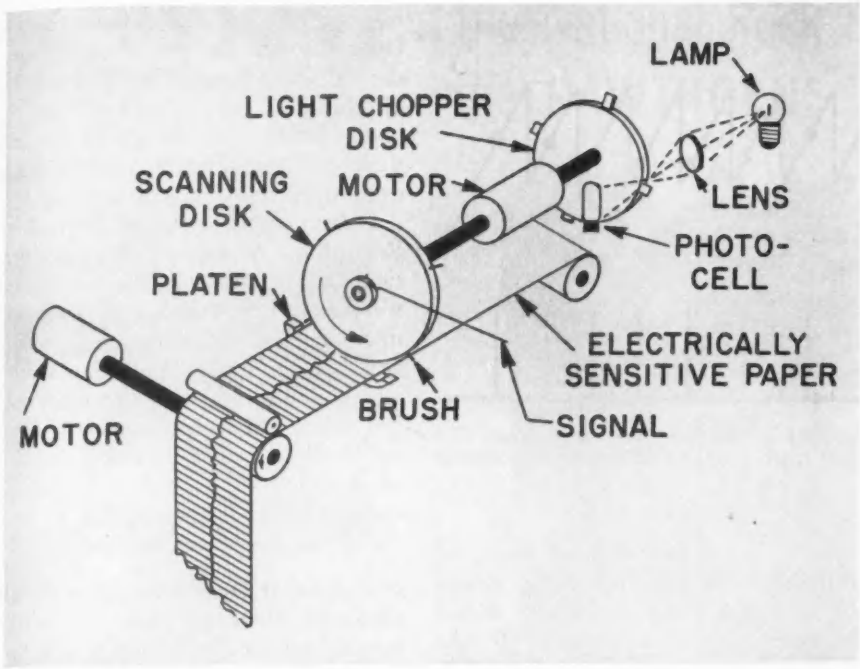


FIGURE 1—Single channel Electrograph. The traces and timing lines are formed by closely spaced dots produced electrically by brushes carried on the edge of a rotating disc.

A method of making multitrace seismic records using electrically sensitive paper has been developed. The record is immediately available for use without any type of processing.

A disc carrying wire brushes on its periphery is revolved with its axis parallel to the direction of the motion of the electrical paper. The paper is pulled under the scanning disc and is shaped so that brushes remain in contact with it.

Short electrical pulses are fed to the brushes to produce a number of traces composed of closely spaced dots. The position of the dots is determined by the time of occurrence of the pulses. This time is a function of the amplitude of the seismic signal. Timing lines are placed on the record by feeding a series of dots to all brushes.

Provision is made to count down and emphasize the fifth and tenth timing lines. A system of multiplexing is used to employ each brush on many traces and thus reduce the rotational speed of the rotating disc.

This recorder has proved its usefulness in reproduction of magnetically recorded seismic data.

Visual Records Made From Magnetically Recorded Data

Electrical recorder converts magnetically recorded seismic data to visual records. Those records may be checked in the field and studied in the interpretation office. Multitrace seismic records are made by using electrically sensitive paper. The records are immediately available for use without any type of processing.

By C. F. Hadley and J. D. Eisler
Pan American Petroleum Corporation, Tulsa

THE USE of magnetic recording in seismic exploration has brought about problems in displaying magnetically recorded seismic data in some useful form. The magnetically recorded seismic data has to be converted to a visual record of some type at least at two different locations.

The seismic data must be checked in the field to ensure that the field equipment and field techniques are satisfactory. This display has much simpler requirements than that normally used in the final interpretation of the data.

The operator of the magnetic recorder in the field must know if the equipment is operating properly, if the noise level is satisfactory, and if the shot is of proper size and has been placed at the optimum depth. It is therefore important that the field operator be able to monitor the output of the magnetic recorder rapidly, since the speed of operation of the crew depends on how fast the operator can make decisions as to the next course of action for the crew.

On the other hand, when the magnetic data is brought to an interpretation office, the records must be reproduced in a precise form, so that computations can be made. It is also important that the display be done as cheaply and conveniently as possible, because magnetically recorded data may produce many different seismic records upon playback.

If the display system is time consuming, the amount of information the interpreter can obtain from the magnetic playback system would be reduced. There are a number of systems which may be used for monitoring in the field or for the production of records suitable for interpretation.

Photographic Oscillograph. One of the best known display systems which has been used for many years is the photographic galvanometer oscillograph. This oscillograph is at a high stage of development, is reliable, and gives high quality seismic records. However, the photographic processing of records is expensive, inconvenient and time consuming. The

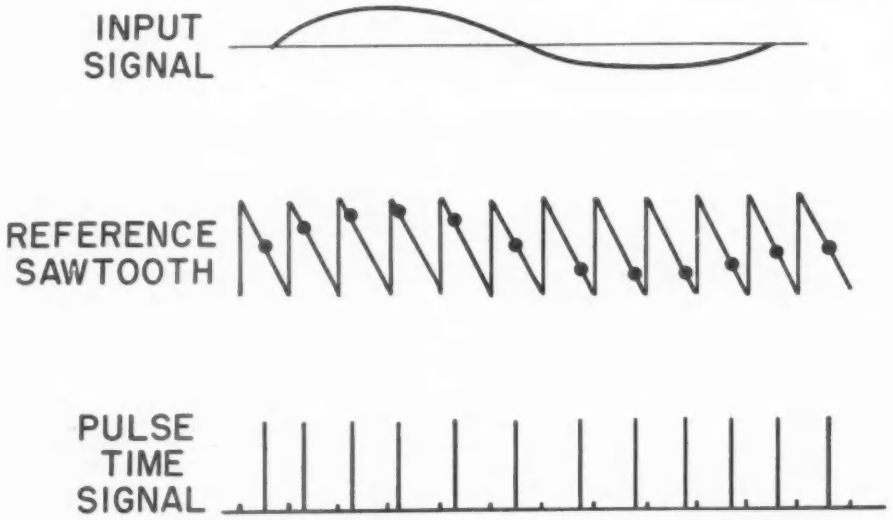


FIGURE 2—Pulse time modulator waveforms. The first line shows the input signal. The comparison of the input signal to a reference saw-tooth voltage and resulting pulse-time signal are shown on second and third lines.

record must be carefully developed and fixed, or it will deteriorate with time. Processing, in the field is particularly difficult, because of the space and time limitations. The geophysical industry has made many attempts in the past to improve or eliminate the photographic process.

Desirable Characteristics of Display Method. A survey made of the various methods for displaying seismic recordings resulted in certain specifications for such equipment as follows: (1) the recording should be rapid, taking no longer than the time to run through the magnetic tape or drum; (2) the recording should not require additional processing; (3) the frequency response should be equal to or better than the standard galvanometer elements; (4) the recording should be rectilinear and have no distortion; (5) the recording should be multitrace, and the traces should be able to cross each other; (6) the system should be able to record timing lines similar to those used on seismic records; (7) the record should be made on a permanent medium and should not deteriorate with time; (8) the recording medium should be reasonable in cost

Medium for Permanent Recording. An investigation of many of the currently available recording media showed that the electrically sensitive paper, called Teledeltos, has many of these advantages. This paper was developed by Western Union Telegraph Company for facsimile use. The paper has three layers. The top layer consists of a thin gray coating. The middle layer consists of a black electrically conductive paper. The bottom layer consists of a thin conducting layer of aluminum paint. If an electrical current is passed from the top layer through the paper to the conducting back layer, the current burns off the gray coating and exposes the black paper underneath. This produces a black line on a gray background.

Other Applications of Permanent Recording. Although the specifications for a desirable display system were determined from the requirements needed for the reproduction of seismic records, a display system which would meet these specifications has many other applications. These applications might include recording of well logs, the readout of analog computers and recording of telemetered data of various types.

Principle of Operation of a Single Channel Electrograph. A recorder employing this electrically sensitive paper is called the Electrograph. To understand its principle of operation, consider first a single trace recorder as shown in Figure 1. A number of wire brushes are mounted around the periphery of a rotating disc. The brushes are drawn in contact across the surface of the paper in the direction perpendicular to the motion of the paper. The paper is formed into a section of the cylinder by a metal platen underneath the paper. The radius of the curvature of the paper is the same as the radius of a circle formed by the tips of the brushes, so that they remain in contact with the paper.

The brushes are spaced around the disc, with the separation between the brushes slightly greater than the width of the paper. Only one brush will be in contact with the paper at any one time. The brushes are connected together electrically, and the circuit is brought out through a slip ring. The platen serves as a ground return for the brush current.

As each brush crosses the recording paper, at some point on the paper an electrical pulse of short duration is passed from the brush through the paper to the platen. The time of occurrence of this pulse determines the position of a dot on the paper. The dots are made so close to each other that they merge into a line.

The input signal is used to control a series of pulses, the time of occur-

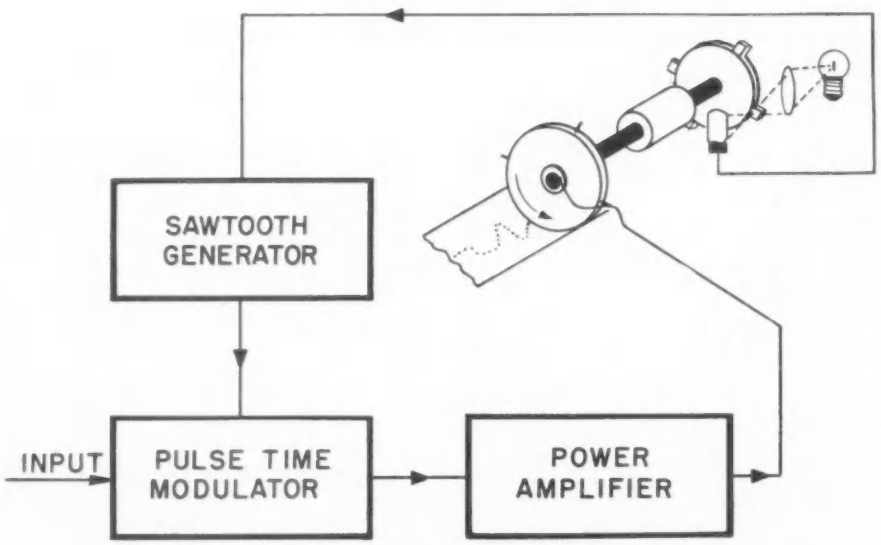


FIGURE 3—Block diagram of single channel Electrograph.

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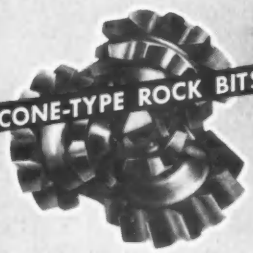

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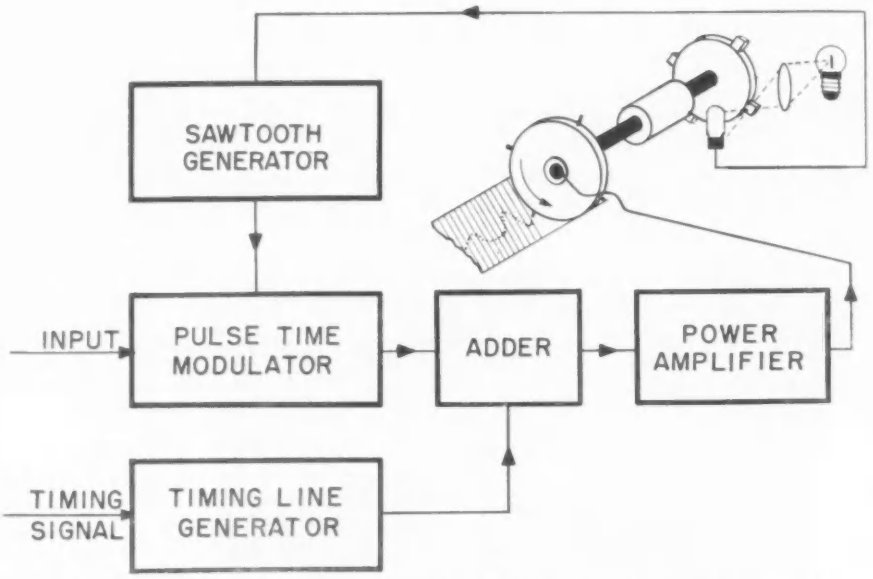

FIGURE 4—Block diagram of single channel Electrograph with timing lines.

rence of which depends on the amplitude of the input signal. The device which performs this operation is called a pulse time modulator. Pulse time modulation is accomplished by comparing the amplitude of the incoming signal with a high frequency saw-tooth voltage. An electronic circuit is arranged to give a short pulse when the amplitude of the input signal is exactly equal to the instantaneous amplitude of the saw-tooth voltage.

Since both positive and negative signals are to be recorded, the signal voltage must be biased with respect to the saw-tooth voltage. The bias is arranged so that with zero signal voltage the bias will equal one-half of the saw-tooth voltage. If the input signal voltage is zero, the pulse time modulated pulse will consist of a series of equally spaced pulses occurring at a time corresponding to half way distance along the slope of the saw-tooth voltage. If the input signal is positive, the pulse will occur earlier than the pulse for zero signal voltage. Likewise, if the input signal is negative, the pulse will occur later. Referring to Figure 2, the shift in time of the pulse with respect to the reference saw-tooth voltage is shown.

During the interval identified by the linear portion of the saw-tooth voltage, a wire brush is crossing the recording paper. Thus, the variation in the time of occurrence of the pulse becomes a similar variation of position of the dot with respect to the edges of the recording paper.

A block diagram of a single channel Electrograph is shown in Figure 3. The pulse time modulator converts the input signal into a series of pulses whose time of occurrence is varied in accordance with the amplitude of the input signal.

A power amplifier is used to amplify the pulses to a sufficiently high voltage to mark the recording paper.

The saw-tooth voltage is generated by a saw-tooth generator, which is synchronized with the rotation of the disc carrying the brushes. The saw-tooth is initiated each time one of the brushes crosses the edge of the paper. The synchronism is controlled by a toothed wheel which interrupts a light beam. The interrupted light is converted into electrical pulses by a photocell. These pulses are amplified and used to initiate the saw-tooth voltage. The toothed wheel has the same number of teeth as the number of wire brushes on the rotating disc.

Principle of Timing Line Generation. Timing lines are simultaneously recorded on the Teledeltos paper. These are similar to the timing lines on a conventional seismic record. A block diagram showing a single channel Electrograph with timing lines is given in Figure 4. The lines are formed by a series of timing line pulses applied to the wire brushes simultaneously with the pulses which produce the trace.

The timing line generator furnishes a burst of high-frequency square wave pulses, whose onset is determined by an external timing signal, such as a tuning fork or a timing signal recorded on the magnetic tape. The duration of the burst of pulses is equal to the time required for a brush to travel across the Teledeltos paper. The frequency of the square wave pulses is sufficiently high so that the individual dots cannot be visually resolved on the record. This line will have a maximum tilt determined by the paper travel during the time required for the brush to travel across the paper. This tilt can be made negligible in the practical instrument. The timing line pulses are added to the time modulated pulses in an adder circuit placed between the pulse time modulator and the power amplifier.

An electronic counting circuit is used to lengthen each fifth and tenth pulse burst to form fifth and tenth timing lines. Two rows of dots are made on fifth and three rows of dots are made on tenth lines by lengthening the pulse duration (see Figure 5). This widening does not impair the accuracy of the front edge of the timing lines.

Principle of Operation of Multiple Trace Electrograph. Seismic information is usually displayed as a multi-trace record. The recording principles used in a single trace unit can be used to produce a multiple trace record. However, a serious practical problem exists in the multiple trace recorder. In such a device, in order to preserve the recording quality, the dot repetition rate cannot be decreased. It is also necessary to keep the rotational speed of the brush disc to a practical value. It is possible to make a multiple trace recording with only one brush contacting the recording paper at a time.

Since the number of dots per second for each trace must remain constant, the velocity of the brushes across the paper will increase in proportion to its width. If a large number of traces spaced at intervals commonly employed in photographic oscillograph are required, a wide paper must be used.

To achieve the dot repetition rate the single brush disc must be either large or it must rotate at a high speed. As an example, a 14-trace recorder would require a brush disc 4 feet in diameter rotating at 3600 rpm or a 7-inch brush disc rotating at 25,000 rpm. Either makes the construction of such an instrument im-

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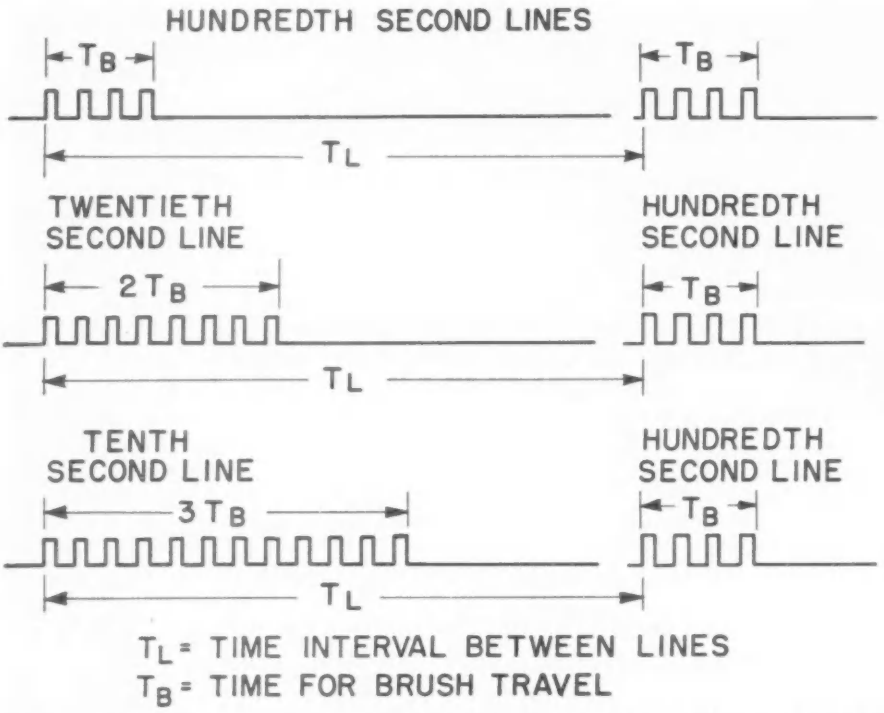

FIGURE 5—Timing line waveforms. Timing line plus trains for hundredth, twentieth and tenth second lines.

practical. This problem can be solved by the use of multiple brushes and a rapid electronic switching technique. In such a system the brushes are switched so that each brush is used several times as it crosses the paper.

An additional feature of a multiple trace record in seismic work is that the traces should be able to cross each other. This provides a compact record in which the character of the individual traces can be more easily followed from one trace to the next. The cross-over of the traces can be obtained by the proper design of the switching system.

In order to simplify the discussion of a multiple channel Electrograph, an example of a four channel Electrograph is next considered. A block diagram of this arrangement is shown in Figure 6. Four pulse time modulators are required. Their outputs pass into the electronic switch which will be described in detail below. After the proper switching the four outputs are passed through four power amplifiers. The pulses from the power amplifiers are applied to the four slip rings on the rotating brush disc. The scanning disc has 16 brushes. Every fourth brush is connected to one of the four slip rings. Four brushes are on the paper at one time with each one of them connected to a different power amplifier.

A single saw-tooth generator is used for all channels. It is synchronized to the brush disc rotation by the synchronizing pulse generated by the toothed wheel interrupting a light beam in the same manner as used in the single trace Electrograph. The brush switching sequence is shown in Figure 7 for a four channel Electrograph in which each trace allowed trace to trace excursion.

The four brushes marked A_1, A_2, A_3, and A_4 are connected together and wired to the commutator slip ring marked A. The brushes marked B_1, B_2, B_3, and B_4 are connected together and wired to the commutator slip ring marked B, etc. Brushes A_1, B_1, C_1, and D_1 will each place a dot on traces 1, 2, 3, and 4, respectively, within one saw-tooth voltage cycle. When brush C_2 moves to the proper position, it will make a dot on trace 1, brush D_2 on trace 2, while brush A_1 makes a dot on trace 3, and B_1 on trace 4. As the brush disc rotation is continued, brush A_2 will make a dot on trace 1, B_2 on trace 2, C_2 on trace 3, and D_2 on trace 4. This pattern of switching will continue.

It can be seen that in this case any one wire brush has to travel only a distance equal to two trace spaces during the time required to generate one dot. If this system were not switched, the single brush would have to travel four trace spaces in the time required to generate one dot. The peripheral speed of the brushes is thus reduced by a factor of two and each brush is used twice as it crosses the paper. The dots forming trace 1 can occur anywhere between the edge of the paper and the undeflected position of trace 2. The dots forming trace 2 can occur anywhere between the undeflected positions of trace 1 and trace 3. The dots forming traces 1 and 2 may cross-over in the region between the undeflected positions of trace 1 and 2.

Rapid rate of switching is required for this application. The switching system used in the Electrograph consists of a large number of controlled

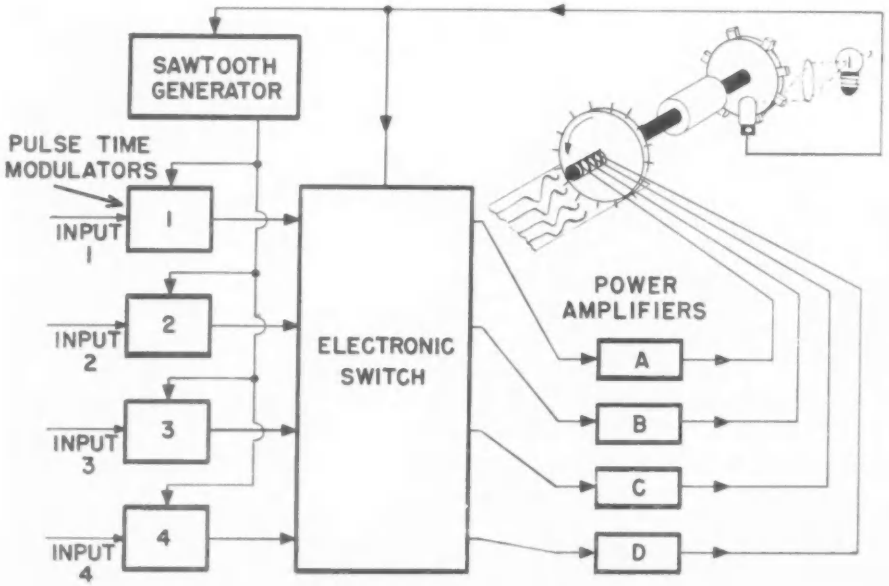

FIGURE 6—Block diagram of four channel Electrograph.

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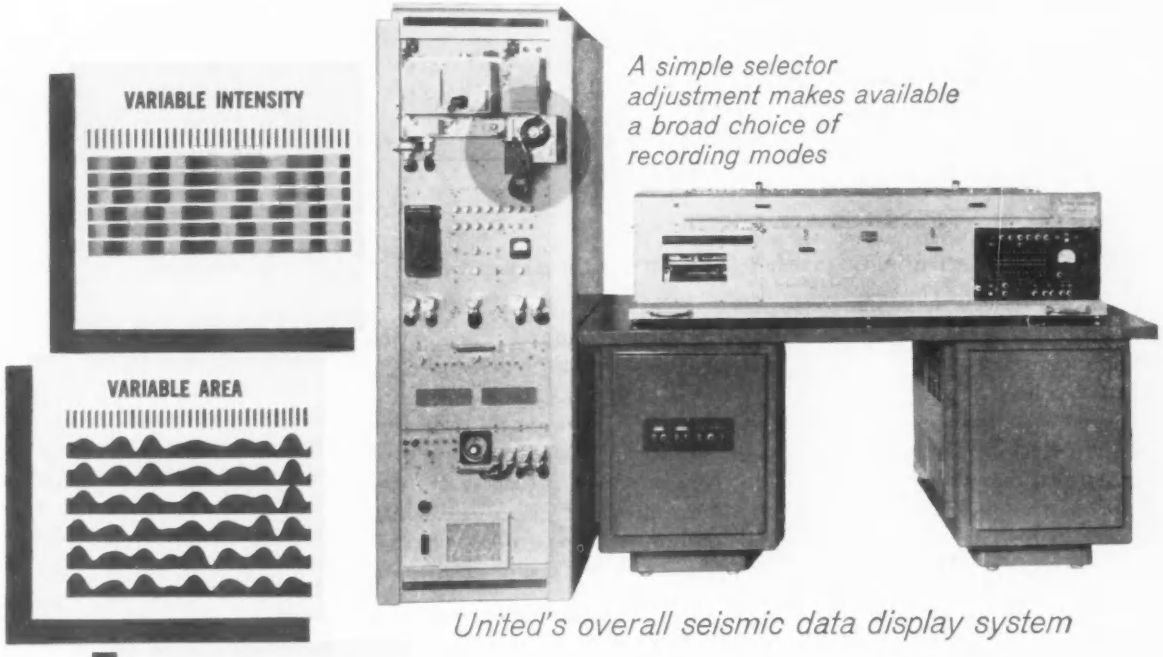

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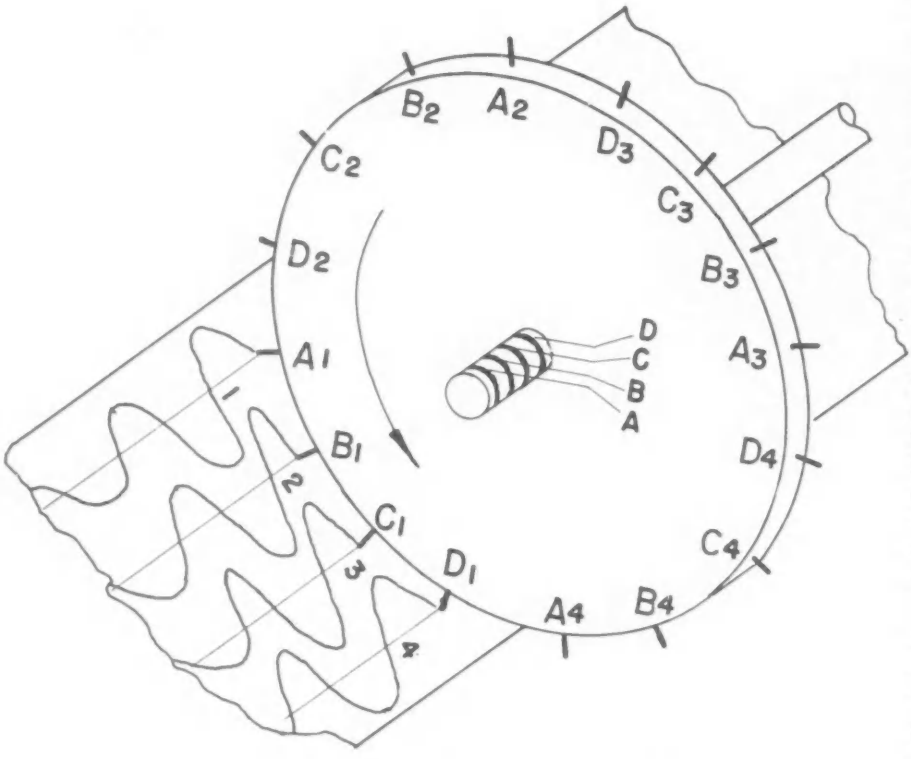

FIGURE 7—Brush switching is used to reduce rotational speed of the brush disc.

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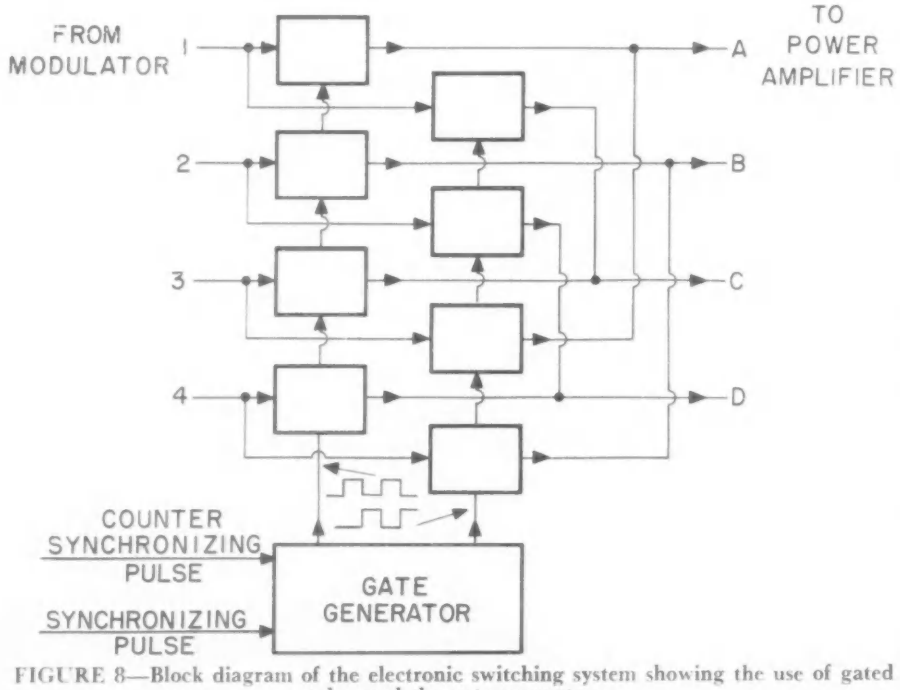

FIGURE 8—Block diagram of the electronic switching system showing the use of gated tubes and the gate generator.

Each output is a square wave which is positive in time sequence.

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FIGURE 9—Physical appearance of complete fourteen channel Electrograph.

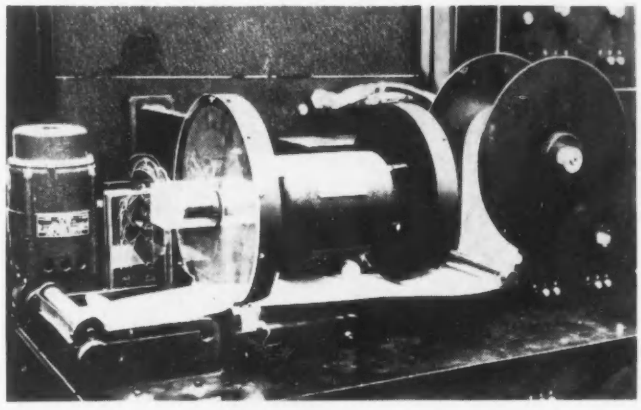

FIGURE 10—Physical appearance of the mechanical portion of the Electrograph.

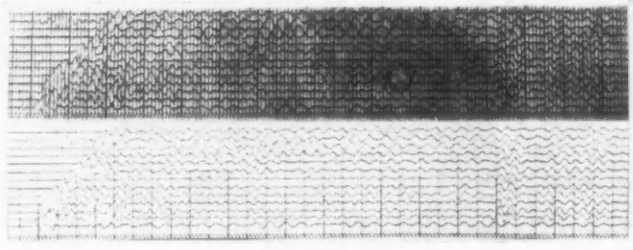

FIGURE 11—Comparison of Electrograph and photographic oscillograph records. The first twelve traces on each record are the result of playback from a magnetic tape through a filter. The thirteenth trace is an unfiltered playback which includes the time break. The fourteenth trace is the timing signal which is used to control the timing lines of the records.

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An example of a seismic record produced by the Electrograph is shown in Figure 11. A photographic oscillograph record obtained from the same magnetic tape is included for comparison. The first 12 traces of each record are the result of playback from a magnetic tape through a filter. The thirteenth trace is an unfiltered playback which includes the time break. The fourteenth trace is the timing signal which is used to control the timing lines on the records.

The Electrograph has been continuously used at Pan American Research Center to reproduce magnetic recorder records with satisfactory results. It enables making playbacks of the magnetically recorded seismic data at a rate which could not be achieved using conventional photographic oscillograph.

ACKNOWLEDGMENT

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Eisler

Charles F. Hadley received his B.S. in 1937 and his M.S. in electrical engineering in 1938 from the California Institute of Technology. In 1944 he received a Ph.D. in electrical engineering from Stanford. He then joined the staff of Radio Research Laboratory at Harvard, and worked on radar countermeasure equipment development. He has previously been employed by Magnolia Petroleum Company and presently is senior research engineer in Pan American Oil Co.'s Exploration division of the Research department.

J. D. Eisler received his B.S. in electrical engineering in 1932 from MIT and his M.S. in electrical engineering in 1954 from Oklahoma University. He was employed by Western Geophysical Co. in 1936 and was transferred to Tulsa to become a member of the research staff of Stanolind Oil and Gas Co. Research Labs in 1938. His work there ranged from instrumental development and design to fundamental seismic research. He is now a research section supervisor in charge of geophysical research.

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Calcium Surfactant Drilling Fluids

Drilling fluid designed to function satisfactorily at high temperatures.

By **R. F. Burdyn** and **L. D. Wiener**
Magnolia Petroleum Company, Research Laboratory
Dallas

IN RECENT YEARS the trend has been toward drilling deeper wells, many of which have bottom hole temperatures exceeding 300° F. The failure of present day drilling fluids to withstand these high temperatures is imposing a serious limitation on the development of deeper oil horizons. This series will describe the laboratory development and field use of a drilling fluid designed to function satisfactorily at high temperatures. Other inherent advantages make its use in wells of moderate bottom-hole temperatures desirable.

Lime-treated drilling fluids are widely used for deep drilling in the Gulf Coast and Mid-Continent areas. Under normal drilling conditions their performance is satisfactory at temperatures as high as 275 to 300° F.[1,2,3] At higher temperatures, due to instability of the drilling fluid additives and interaction of the drilling fluid components, control of properties becomes increasingly difficult. Oil base drilling fluids have been used successfully in drilling deep holes at temperatures in excess of 300° F. terpretation, drilling rate, and maintaining high density.[4,5,6]

Deep, Hot Holes. The unsatisfactory performance of conventional water base drilling fluids at elevated temperatures may be attributed to two factors: degradation of additives and chemical reaction between additives and silicate minerals in the drilling fluid.[1] An accumulation of reaction products may be detrimental to drilling fluid properties and eventually result in high-temperature solidification. In either case, additives are consumed and must be replaced as drilling continues. Consumption of drilling fluid additives is first evidenced by a significant increase in maintenance requirements. As the bottom-hole temperature increases, these requirements may approach total replacement of all unstable additives for each circulation of the drilling fluid through the hole.

Serious difficulties may arise as a result of poor drilling fluid properties caused by exposure to high temperature. For example, high-temperature solidification or excessive gel strengths can be responsible for pressure surges tions are conducive to loss of circulation.[7] In addition, logging tools may be prevented from reaching bottom because of the excessive gel strengths. These difficulties and the need for extensive mud conditioning after trips can add up to an appreciable amount of lost rig time.

It is generally thought that a drilling fluid filtrate containing calcium ions will tend to reduce clay swelling and dispersion. Due to the reaction of lime and caustic soda with silicate minerals at elevated temperatures, lime-treated muds after circulating through a "hot hole" will often show a marked decrease in available calcium. If large excesses of lime are not maintained, the calcium ion could disappear from the aqueous phase, thereby producing essentially a fresh water filtrate. As a result, the possibility of heaving shale would increase, the drilling fluid would have a greater tendency to disperse drilled shales leading to an increase in solids content, and damage to a productive formation would be more likely.

High-Temperature Drilling Fluid. From an analysis of difficulties that have been encountered in the drilling

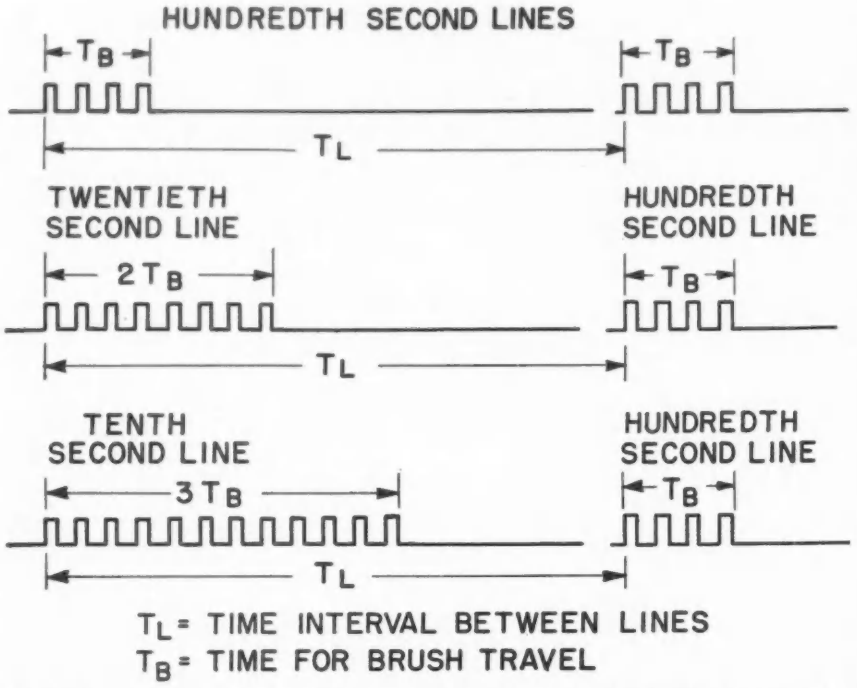

FIGURE 5—Timing line waveforms. Timing line plus trains for hundredth, twentieth and tenth second lines.

practical. This problem can be solved by the use of multiple brushes and a rapid electronic switching technique. In such a system the brushes are switched so that each brush is used several times as it crosses the paper.

An additional feature of a multiple trace record in seismic work is that the traces should be able to cross each other. This provides a compact record in which the character of the individual traces can be more easily followed from one trace to the next. The cross-over of the traces can be obtained by the proper design of the switching system.

In order to simplify the discussion of a multiple channel Electrograph, an example of a four channel Electrograph is next considered. A block diagram of this arrangement is shown in Figure 6. Four pulse time modulators are required. Their outputs pass into the electronic switch which will be described in detail below. After the proper switching the four outputs are passed through four power amplifiers. The pulses from the power amplifiers are applied to the four slip rings on the rotating brush disc. The scanning disc has 16 brushes. Every fourth brush is connected to one of the four slip rings. Four brushes are on the paper at one time with each one of them connected to a different power amplifier.

A single saw-tooth generator is used for all channels. It is synchronized to the brush disc rotation by the synchronizing pulse generated by the toothed wheel interrupting a light beam in the same manner as used in the single trace Electrograph. The brush switching sequence is shown in Figure 7 for a four channel Electrograph in which each trace allowed trace to trace excursion.

The four brushes marked A_1, A_2, A_3, and A_4 are connected together and wired to the commutator slip ring marked A. The brushes marked B_1, B_2, B_3, and B_4 are connected together and wired to the commutator slip ring marked B, etc. Brushes A_1, B_1, C_1, and D_1 will each place a dot on traces 1, 2, 3, and 4, respectively, within one saw-tooth voltage cycle. When brush C_2 moves to the proper position, it will make a dot on trace 1, brush D_2 on trace 2, while brush A_1 makes a dot on trace 3, and B_1 on trace 4. As the brush disc rotation is continued, brush A_2 will make a dot on trace 1, B_2 on trace 2, C_2 on trace 3, and D_2 on trace 4. This pattern of switching will continue.

It can be seen that in this case any one wire brush has to travel only a distance equal to two trace spaces during the time required to generate one dot. If this system were not switched, the single brush would have to travel four trace spaces in the time required to generate one dot. The peripheral speed of the brushes is thus reduced by a factor of two and each brush is used twice as it crosses the paper. The dots forming trace 1 can occur anywhere between the edge of the paper and the undeflected position of trace 2. The dots forming trace 2 can occur anywhere between the undeflected positions of trace 1 and trace 3. The dots forming traces 1 and 2 may cross-over in the region between the undeflected positions of trace 1 and 2.

Rapid rate of switching is required for this application. The switching system used in the Electrograph consists of a large number of controlled

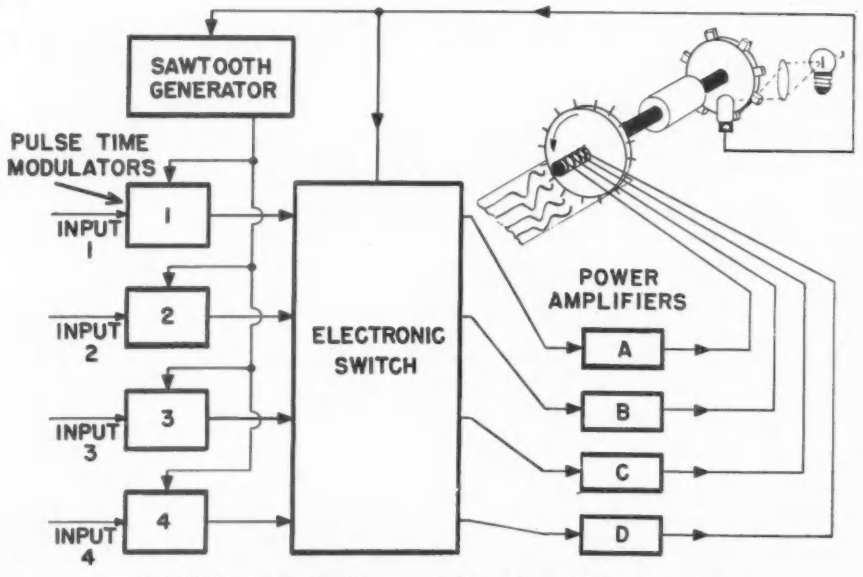

FIGURE 6—Block diagram of four channel Electrograph.

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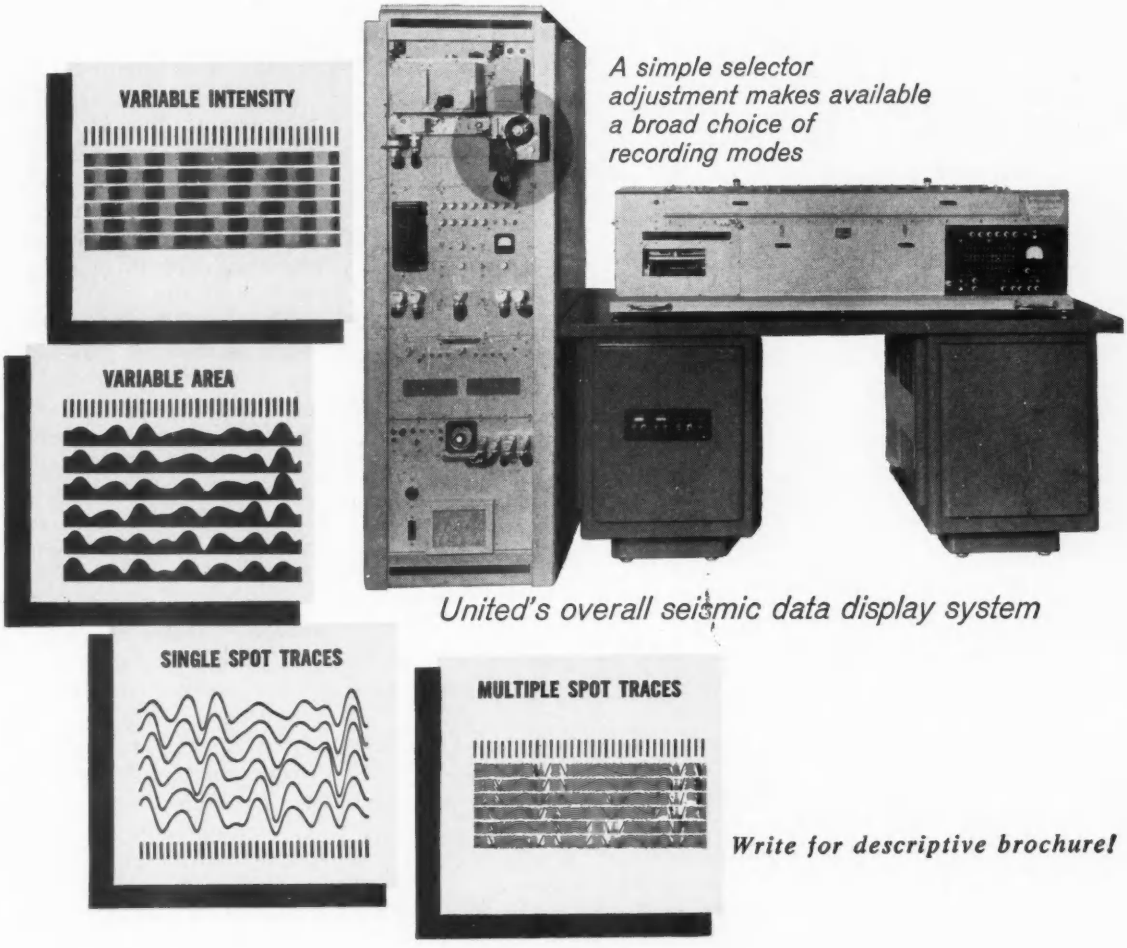

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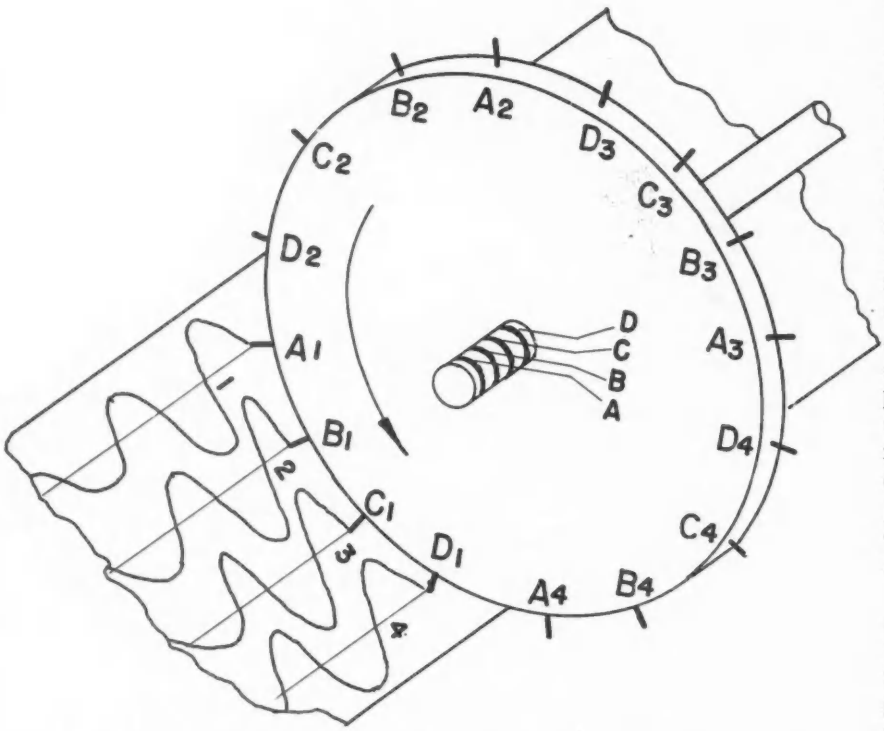

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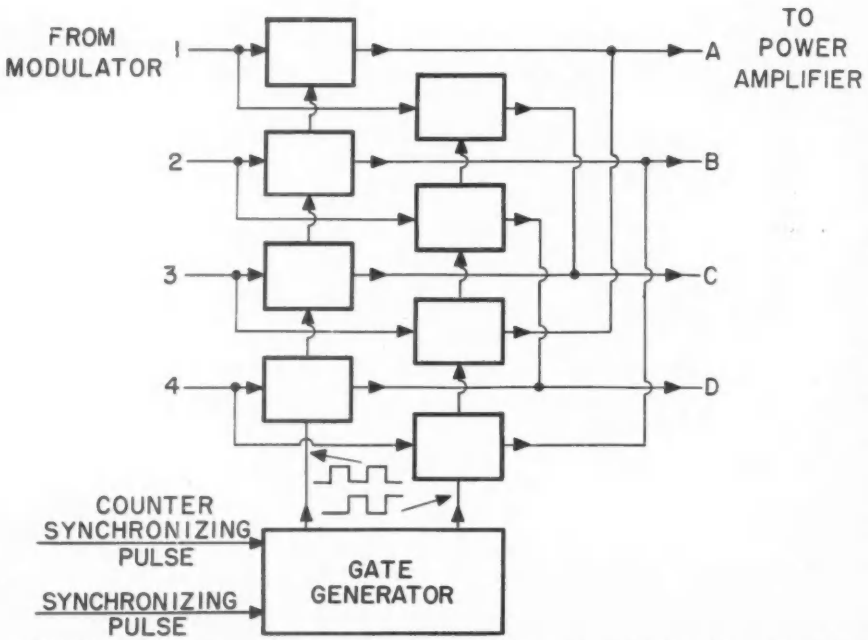

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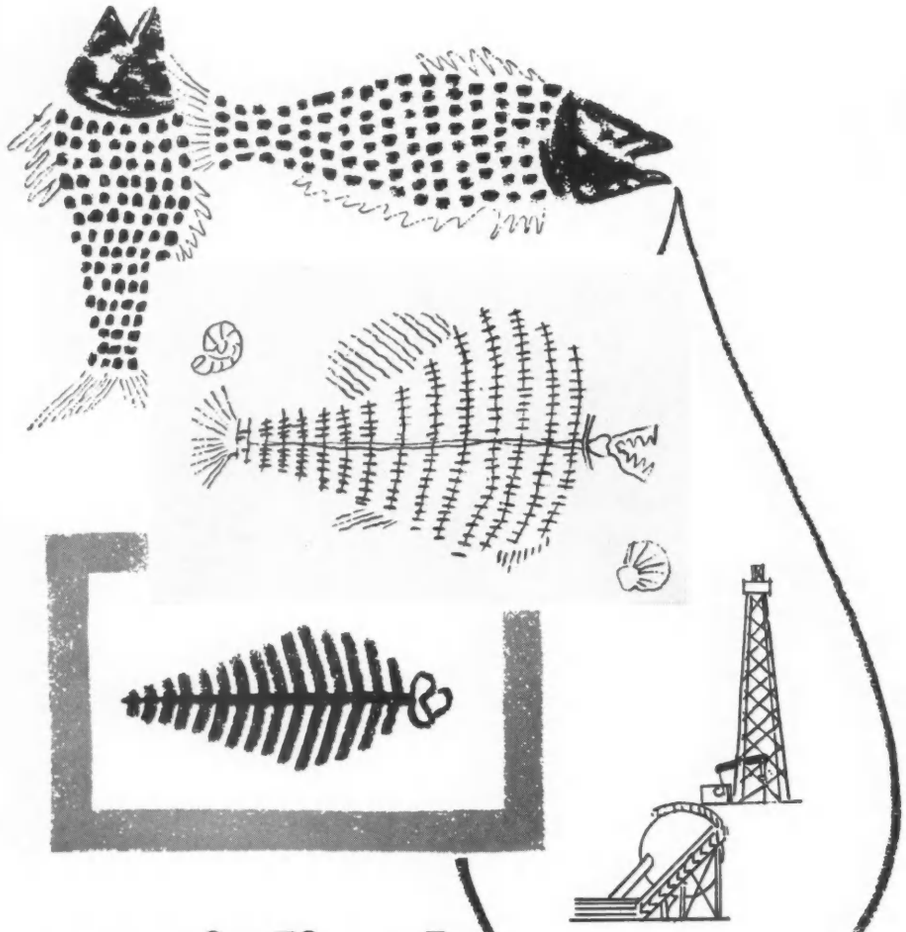

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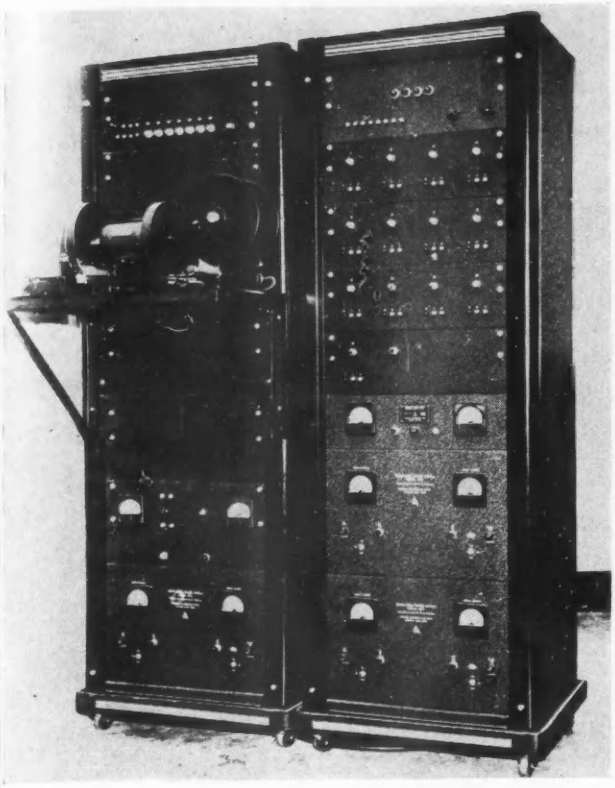


FIGURE 9—Physical appearance of complete fourteen channel Electrograph.

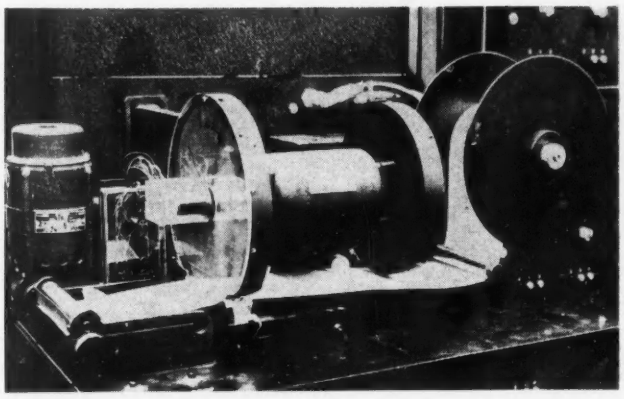
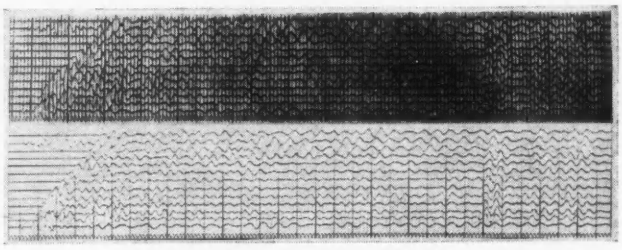


FIGURE 10—Physical appearance of the mechanical portion of the Electrograph.



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Calcium Surfactant Drilling Fluids

Drilling fluid designed to function satisfactorily at high temperatures.

By **R. F. Burdyn** and **L. D. Wiener**
Magnolia Petroleum Company, Research Laboratory
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High-Temperature Drilling Fluid. From an analysis of difficulties that have been encountered in the drilling of high-temperature wells with conventional water base drilling fluids,

the following basic requirements are proposed for a high-temperature drilling fluid.

1. Stability and Inertness of Mud Components—Need for a Neutral System. Interaction of the mineral constituents of a drilling fluid with mud additives, on exposure to the high temperatures encountered in bore holes, is minimized when the pH of the aqueous phase is maintained at or near the neutral point. Thus, the pH of a high-temperature drilling fluid should be governed solely by the buffering action of the clays present (between 8 and 9). Use of caustic soda and lime would necessarily be eliminated.

Organic mud additives undergo chemical change in drilling fluids to varying degrees dependent upon their structure, essentially as a result of hydrolytic, oxidative, and pyrolytic degradation. In all cases, the rates of degradation increase with temperature and eventually drilling fluid properties cannot be satisfactorily maintained during the interval between successive chemical additions. This interval is much greater when changing bits than while drilling, and at these times the onset of control difficulties is most readily apparent.

A satisfactory high-temperature drilling fluid must then contain additives which are themselves stable to high temperatures and chemically inert toward the naturally present argillaceous material.

2. Non-Dispersing Tendency—Need for an Inhibited System. Many of the shortcomings of conventional drilling fluids can be attributed to their tendency to disperse drilled solids. By the choice of an aggregated (controlled flocculated) system*, which is inherently non-dispersing in character, the following advantages may be gained:

a. Stability toward electrolyte contamination is greater.

b. The filtrate, if also non-dispersing in character, is less damaging to producing formations.

c. Formation damage from particle invasion is less since particle size is greater.

d. Solids carrying capacity is greater.

e. Dispersion and incorporation of drilled solids into the drilling fluid is reduced.

f. Hole stability is improved since the non-dispersing character of the system tends to minimize swelling and sloughing of shales invaded or contacted by mud filtrate.

Considering these factors, the clay solids in a high-temperature drilling fluid should be in a relatively high degree of aggregation and contain no additives which exert a strong dispersing action on clays (or shales). In addition, the aggregants employed should be present in sufficient amount to maintain their effectiveness for extended periods of exposure to high temperatures. The concentration of aggregants in the filtrate should be sufficient to inhibit swelling of shales.

3. Good Logging Properties—Need for a Controllable Resistivity. Control of the electrical resistivity of the mud is desirable since many wells requiring a drilling fluid of this type will be exploratory where good SP delineation is essential for detection of sands. Likewise, for most accurate log interpretation, the resistivity should be predictable and stable. Stability of the drilling fluid components will insure a stable value of resistivity.

The SP as recorded on the electric log is the sum of the electrochemical potential between the mud filtrate and the formation water and the streaming potential produced by the passage of filtrate through the filter cake.[4,6] The magnitude of the streaming potential is proportional to both the charge on the clay particles comprising the filter cake and the resistivity of the filtrate. Since R_W calculations from SP logs should be based solely on electrochemical potential, the streaming potential should be eliminated. When a high resistivity filtrate is desirable from the standpoint of electrochemical potential, maximum reduction in the charge on the clay platelets is essential. This reduction is inherent in an aggregated system.

Summarizing, a drilling fluid satisfactory for drilling deep hot holes should be of the inhibited type, have a neutral pH, require no pH control, have a controllable electrical resistivity, and utilize additives which are heat stable and non-reactive at bottom hole conditions. As will be shown, a neutral non-ionic surfactant drilling fluid provides a closer approach to these ideal properties than presently used drilling fluids.[8]

*An aggregated system is characterized by a plate-to-plate parallel stacking of the individual clay particles. The contribution of the clays to the plastic viscosity is thereby greatly reduced and they act more as inert suspended solids.

EFFECTS OF NON-IONIC SURFACTANTS ON CLAYS

Characteristics of Non-Ionic Surfactants.[9,10] An important class of available compounds representing non-ionic surfactants are those which contain a hydrophobic portion consisting of either a long paraffin hydrocarbon chain, an aromatic, or an alkylated aromatic group, and a hydrophilic portion (or water solubilizing group) consisting of a polyoxyethylene chain. In the investigation of the effect of surfactant treatment on clay slurry properties, compounds of this class were employed.

Non-ionic surfactants have the following unique characteristics relative to their adsorption on clay surfaces:

1. The polar groups which control the hydrophile-hydrophobe balance of the molecule are non-ionogenic, and consequently solubility and surface activity are relatively unaffected by substantial concentrations of electrolyte.

2. The state of charge on the clay surface has little effect on the extent of adsorption of non-ionic surfactants.[11]

3. Compared to ionogenic surfactants, non-ionics offer a closer control over the hydrophile-hydrophobe balance, because the solubilizing effect of each non-ionizing polar group added is much smaller than that of ionizing polar groups, and the number of polar groups in the molecule may be easily varied in small increments.

Basic Behavior of Non-Ionic Surfactant-Clay (Montmorillonite) System. Preliminary experiments showed that non-ionic surfactants are adsorbed out of aqueous solution on the clay surfaces.[11,12] X-ray studies showed that there is mono-layer adsorption and that the adsorbed molecules lie flat on the clay platelets. Therefore the amount of surfactant adsorbed is proportional to the specific surface area of the clay. Where an essentially complete monolayer of surfactant has been adsorbed on the clay platelets, it appears that the hydrated sheath thus formed acts as a barrier which drastically limits the physico-chemical interaction between clay particles. Since both dispersive forces and attractive forces are affected, the degree of dispersion and the gel-forming tendency are reduced. Thus, the sur-

actant causes aggregation of the clay particles, and a clay slurry treated with non-ionic surfactant undergoes a decrease in plastic viscosity because the treated slurry contains fewer and larger aggregates which are less asymmetric in shape. The yield point and gel strengths of the treated slurry are reduced because of the reduced interaction between aggregates.

Selection of Specific non-ionic surfactants for use in drilling fluids. In selecting the non-ionic surfactants most ideally suited for use in drilling fluids, the following factors were considered:

1. Stability toward hydrolysis or other chemical reactions
2. Adsorptivity and aggregating effect on clay solids
3. Solubility at elevated temperatures
4. Ability to act as emulsifier for oil
5. Foaming tendency.

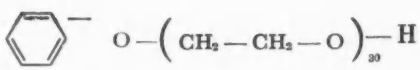
These factors are considered in detail below.

Due to the somewhat greater ease of hydrolysis of compounds containing an ester, amide, or amine linkage as compared to those with an ether linkage, the latter type is preferable. This type of linkage is found in compounds with alcohols or phenols as the hydrophobic group.

Factors 2, 3, 4, and 5 above are all related in that they are dependent (to varying degrees) on the hydrophile-hydrophobe balance in the surfactant molecule. It should be realized that a single compound will probably not display optimum properties in regard to all of these factors. For example, the compound with the balance adjusted to yield maximum aggregating effect would very likely have considerable tendency to foam, be a good emulsifier of oil, and have undesirably low solubility at elevated temperatures. (The solubility of non-ionic surfactants decreases with increase in temperature to a point where they eventually become inactive). Conversely, a compound with the balance adjusted to yield a minimum foaming tendency (the balance more in favor of the hydrophile) would probably possess a relatively poor aggregating effect and emulsifying power, but might have good solubility at elevated temperatures. Thus, a compromise must be reached in the final product either by selecting a single compound which only partially meets these requirements, or by selecting two or more compounds, the combination of which more closely approaches the optimum.

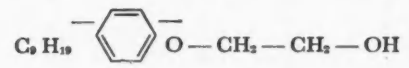
In the selection discussed here, a combination of surfactants is used consisting of a primary surfactant, a defoamant, and an emulsifier.

Primary Surfactant. A phenol-30 mol ethylene oxide adduct (hereafter designated as P-30) is used as the primary surfactant. Its structural formula is:

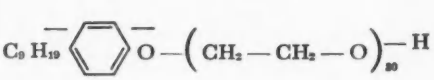


This material provides control of the rheological properties and increased efficiency of the water loss reducing agent. It also adsorbs on metal surfaces to provide better lubrication and cleaner bits.

Defoamant. This is a predominantly oil-soluble material, nonyl phenoxyethanol (hereafter designated as NP-1), with the structural formula:



Emulsifier. The emulsifier, a 30-mol ethylane oxide adduct of nonyl phenol (hereafter resignated as NP-30) has the structural formula:



With the primary surfactant present in excess, low concentrations of the emulsifier produce extremely stable emulsions.

CALCIUM SURFACTANT DRILLING FLUID

Although primary surfactants of the type described are effective as aggregants in all water base drilling fluids, this paper will be confined to their application in calcium-containing systems. The aggregation of the clays in this drilling fluid is accomplished more completely by the use of both calcium sulfate and P-30 than by the use of either one alone. The resultant drilling fluid is relatively insensitive to electrolyte contamination, and causes a minimum dispersion of drilled solids. The filtrate containing a high concentration of aggregate effectively inhibits the swelling of clays.

Calcium sulfate was selected as the source of calcium ions because of its desirably low degree of solubility from the standpoint of electrical resistivity. Nevertheless, it provides a concentration of calcium ion in the aqueous phase much greater than that obtained with lime-treated muds. A saturated solution at room temperature (77° F.) contains 2.1 grams of calcium sulfate per liter (620 ppm calcium ion) and has a resistivity of 4.5 ohm-meters. As large an excess of undissolved calcium sulfate as needed may be maintained without altering the drilling fluid properties. In addition, since it is a neutral salt, it has virtually no effect on the pH of the drilling fluid.

The surfactants, calcium sulfate, and a water loss reducing agent such as sodium carboxymethylcellulose

TABLE 1
Effect of Order of P-30 Addition on Slurry* Properties

Order of Addition to Water	Plastic Viscosity (cp)	Yield Point (Lb./100 Ft.²)	Gel Strength	
			Initial (Lb./100 Ft.²)	10-Minute (Lb./100 Ft.²)
Bentonite—No. P-30	41	44	8	31
Bentonite—P-30	33	27	3	14
P-30—Bentonite	20	9	1	4

* 4.5 weight percent commercial bentonite.

TABLE 2
Effect of Electrolytes on Bentonite Slurries* Treated With Excess P-30

Treatment	Plastic Viscosity (cp)	Yield Point (Lb./100 Ft.²)	Gel Strength		API 30-Min. Water Loss (cc)
			Initial (Lb./100 Ft.²)	10-Min. (Lb./100 Ft.²)	
None	41	30	12	43	11.4
P-30	33	12	1	23	12.2
10-Percent Salt	12	73	43	47	62.6
10 Percent Salt—P-30	3	1	1	1	284
5 Percent Anhydrite	12	14	9	27	43.8
5 Percent Anhydrite—P-30	11	8	2	5	40.6

* 6 percent commercial bentonite by weight.

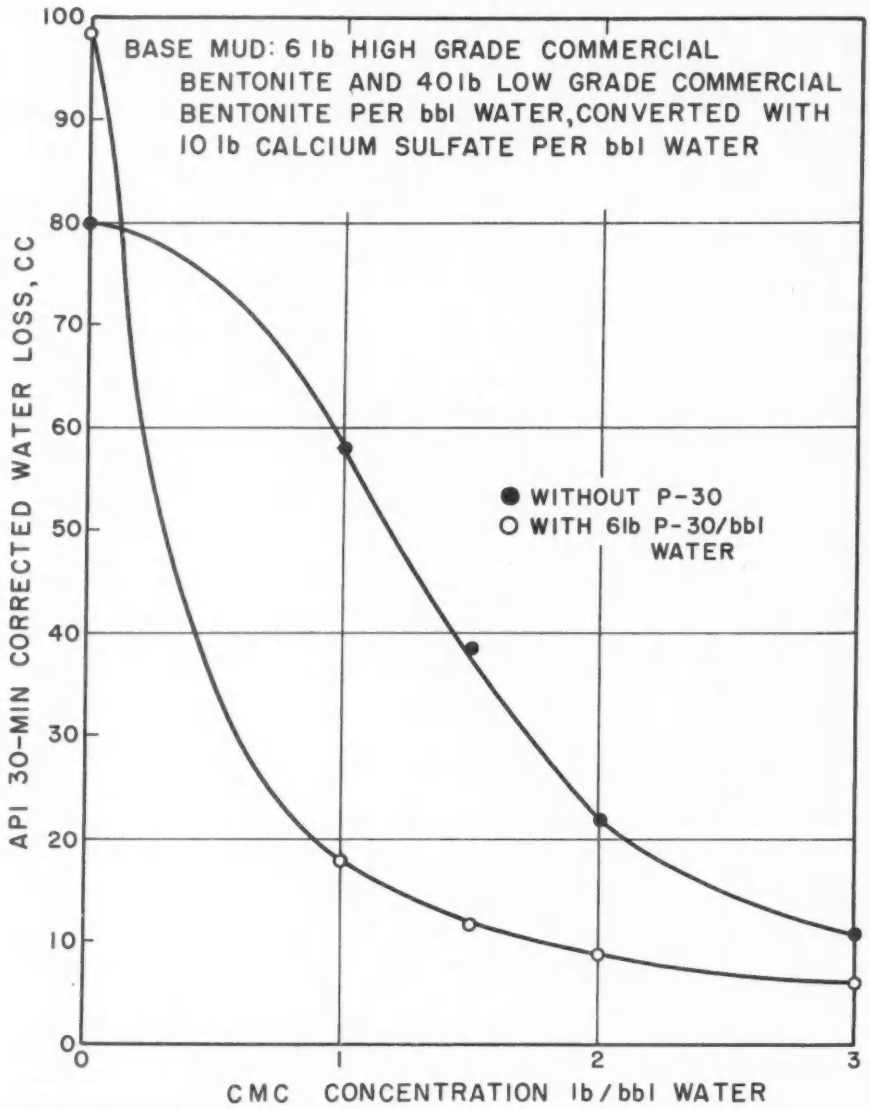


FIGURE 1—Effect of P-30 and CMC on water loss of calcium surfactant mud.

(CMC) are the only additives required for the maintenance of the calcium surfactant mud.

Laboratory Results. Aggregating Effect of Primary Surfactant (P-30). In a fresh water clay slurry in which P-30 is present in excess as the primary surfactant, the extent of aggregation is dependent upon the amount of electrolyte present and the order of addition of P-30 and clay. It appears that for P-30 to act as an aggregant in a montmorillonite slurry, the presence of some electrolyte is essential. In a dispersion of highly purified sodium montmorillonite in water, P-30 has essentially no aggregating effect, i.e., plastic viscosity[13,14] remains constant after treatment with P-30. When added to a slurry of commercial bentonite contaminated with salt, it increases the degree of aggregation of the system as evidenced by a decrease in plastic viscosity.

The order of addition of the clay and P-30 to water in preparing a slurry is a significant factor in determining final slurry properties. In this regard, the P-30 functions the same as any other aggregant, exhibiting a marked inhibiting effect on the hydration and dispersion of dry or partially hydrated clay. Table 1 shows the rheological properties of bentonite slurries in which the order of addition of bentonite and P-30 to water has been varied.

It will be noted that the yield point and gel strengths are reduced in the presence of P-30. This is typical behavior and is illustrative of the action of non-ionic surfactants in reducing interaction between particles.

The data in Table 1 also show tha a fresh water slurry treated with suf- ficient P-30 for monolayer adsorptio on the clays undergoes a decrease i plastic viscosity which is evidence of higher degree of aggregation. How ever, the extent of aggregation small, and the particles are still in highly charged state; consequently, th system is still susceptible to contami nation by electrolyte. When salt or an hydrite is added to a P-30 treate slurry, an initial thickening occurs i much the same manner as it would i an untreated slurry. After aging an agitation, however, it may be see (Table 2) that the presence of P-3 causes a higher degree of aggregatio as evidenced by a general lowering o plastic viscosity, yield point, and ge strengths.

Effect of CMC and P-30. A low solids laboratory mud was converte with calcium sulfate and treated wit varying amounts of CMC and P-3 to show the effect of these materia on the fluid loss of a calcium system Figure 1 shows these results. Additio of an excess of P-30 to the CMC treated system brings about an appre ciable decrease in water loss rangin from 42 to 71 per cent. Comparin the two curves at constant water los it will be noted that the P-30 syste achieves the same water loss with ap proximately one-half the CMC re quirements of the system withou P-30.

CMC (as well as other anioni polymers), in addition to performin as a water loss reducing agent in a cal cium-aggregated clay slurry, also re duces the yield point and gel strength Evidently appreciable adsorption o CMC takes place, whereupon it func tions as a protective colloid and th interaction between aggregates i thereby reduced. Since the CMC mol ecule is partially ionized even in th presence of calcium ion, a charge i imparted to the aggregate on which it adsorbs. In the adsorbed state CMC is considerably less effective in reduc ing water loss. When P-30 is added t a calcium-aggregated clay system con taining CMC, desorption of part o the CMC apparently occurs and a marked improvement in water loss i noted.

Solids Carrying Capacity. A simila low-solids laboratory mud was con verted with calcium sulfate an

reated with 2 pounds of CMC and 6 pounds P-30 per barrel of water present. To this mud varying amounts of additional clay were added along with 0.15 pound P-30 per pound clay. A similar group of samples was also prepared in which no P-30 was present. The results showing the effect of added clay solids are given in Figure 2, in which the water loss is plotted against clay solids added, and in Table 3 where the change in rheological properties with increasing solids concentration is shown. The rheological properties are significant in that at low solids concentration addition of P-30 causes an increase in plastic viscosity, yield point and gel strengths, whereas at the higher solids concentrations the reverse is true. In effect, this means that the presence of P-30 improves suspending ability of the fluid at low solids content yet permits a high solids concentration to be carried before a drastic increase in the rheological properties occurs.

The effect of P-30 in high-solids drilling fluids has also been demonstrated for drilling fluids containing various amounts of barite weighting material. Table 4 is a comparison of properties of such systems with and without P-30 present.

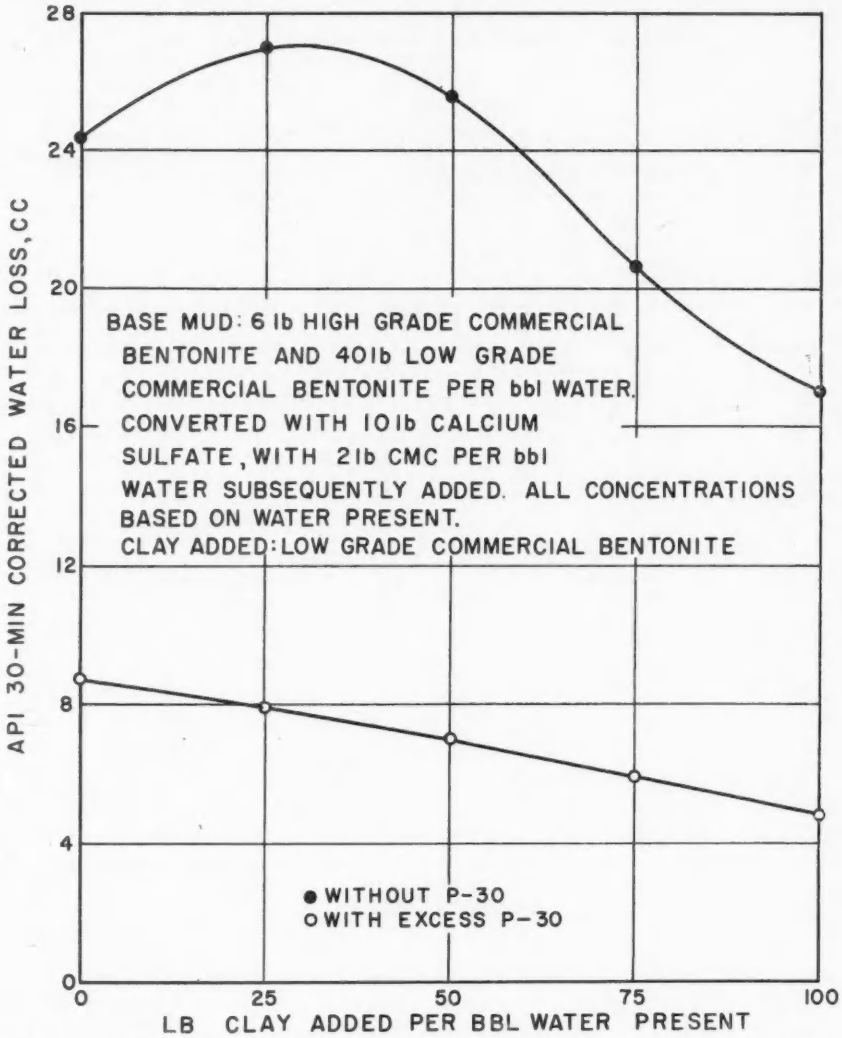


FIGURE 2—Effect of P-30 and CMC on water loss of a calcium surfactant mud containing added clay solids.

High Temperature Studies. Representative calcium surfactant drilling fluids at several solids concentrations were placed in sealed containers and subjected to temperatures of 325 to 400° F. for periods up to 72 hours. Shearometer[15] tests were then performed to determine the cementation tendency. As might be predicted, since the system has a pH in the range of 8 to 9, it does not exhibit this phenomenon. In these same tests, it was observed that the CMC degrades rapidly. However, field testing in a well at this temperature has shown that the degradation proceeds more slowly than these laboratory tests would indicate. The difference in results is thought to be due in part to the presence of less oxygen (air) in field mud systems and in part to the high concentration of partially degraded CMC, built up through maintenance additions, which reacts with the oxygen. In all cases, further additions of CMC restore drilling fluid properties to their original values before degradation. Thus, CMC is the only component in the present composition that is not completely stable.

Water losses were also measured at elevated temperatures before any appreciable CMC degradation had occurred. These data are in agreement with the predicted increase attributable to the viscosity change in the aqueous phase.[16] Hence, there are no

TABLE 3
Properties of Calcium Surfactant Drilling Fluids* At Increasing Clay Concentrations**

Clay Added to Base Mud (Lb./Barrel Water)	Plastic Viscosity (cp)	Yield Point (Lb./100 Ft.²)	Gel Strengths		API 30-Min. Water Loss (cc)
			Initial (Lb./100 Ft.²)	10-Min. (Lb./100 Ft.²)	
PROPERTIES WITH AN EXCESS OF P-30 MAINTAINED					
0	25	4	1+	3+	8.7
25	35	5	2	10	7.9
50	62	8	3+	25	7.0
75	87	16	11	65	5.9
100	120	41	47	170	4.8
PROPERTIES WITHOUT P-30 PRESENT					
0	12	1	1+	1+	24.5
25	36	3	3+	17	27.0
50	82	15	24	68	25.5
75	131	70	49	92	20.6
100	>250	>200	120	200	16.5

* Base Mud contains 6 lb./barrel high grade commercial bentonite, 40 lb./barrel low grade commercial bentonite. Converted with 10 lb./barrel calcium sulfate, with 2 lb./barrel CMC subsequently added. All concentrations based on water present.
** Low grade commercial bentonite.

TABLE 4

Properties of Weighted Calcium Surfactant Drilling Fluids*

Mud Weight (Lb./Gal.)	Mud Weight (Lb./Cu.Ft.)	Plastic Viscosity (cp)	Yield Point (Lb./100 Ft.²)	Gel Strengths Initial (Lb./100 Ft.²)	Gel Strengths 10-Min. (Lb./100 Ft.²)	API 30-Min. Water Loss (cc)
PROPERTIES WITH 3 LB. P-30 PRESENT PER BARREL WATER						
9.4	70.3	9	2	1	1+	5.3
12.2	91.3	17	2	1	1+	7.4
13.3	99.5	20	2	1	3	7.7
16.6	124.2	38	6	1	14	9.4
18.8	140.6	107	37	11	68	13.0
PROPERTIES WITHOUT P-30 PRESENT						
9.4	70.3	6	0	1	1+	11.9
12.2	91.3	13	4	1+	21	13.7
13.3	99.5	17	7	3	36	15.4
16.6	124.2	30	36	34	162	18.4
18.8	140.6	→	> 200	200	300	24.3

* Base mud contains 9 lb./barrel high grade commercial bentonite, 43 lb./barrel low grade commercial bentonites and illites, and 18 lb./barrel finely divided quartz. Converted with 10 lb./barrel calcium sulfate, with 2 lb./barrel CMC subsequently added. All concentrations based on water present.

unpredictable temperature effects on water loss.

The calcium surfactant drilling fluid using P-30 as the primary surfactant and CMC as the water loss agent was field tested in drilling four wells. A fifth well was drilled in which a polyacrylate type material was used in place of CMC for filtration control. Certain general information about each of these wells is tabulated in Table 5.

The amounts of calcium sulfate and P-30 used to convert a fresh water mud are dependent upon the quantity and activity of clays present in the fresh water mud and the desired excesses of the calcium sulfate and P-30 to be maintained. The amount of water loss agent required initially is determined by the desired water loss.

The conversion procedure was as follows: the calcium sulfate was added first and sufficient time allowed for it to react completely with the clays in the fresh water mud. For purposes of bringing the water loss under control as quickly as possible, the CMC was then added, followed by the surfactant.

The mud properties are practically unaffected by an excess of calcium sulfate in the range of 2 to 20 pounds/barrel. A value of 5 pounds/barrel was selected as a suitable excess to be maintained in field muds. Similarly, in the case of P-30 any excess concentration in the filtrate within the range of 0.5 to 10 pounds/barrel is satisfactory; a suitable value of about 1.5 pounds/barrel was chosen.* In oil emulsion systems approximately 0.1 pound/barrel of NP-30 per volume percent of oil was used.

With the calcium sulfate and surfactant maintained at the proper excess by tourly additions of these materials, and water loss controlled at the desired level by tourly addition of CMC, it was possible to vary the viscometric properties within wide limits by adjusting the light solids content of the mud with either water or clay additions. Maintenance additions of NP-30 for the emulsion systems were governed by the appearance of oil in the pits.

Typical of the properties obtained in the field calcium surfactant muds are those shown in Table 6, for Well D. A brief description of each trial follows:

Well A: The first field trial of the calcium surfactant drilling fluid was carried out for the purpose of evaluating the laboratory-developed drilling fluid under actual drilling conditions in the field preparatory to testing the mud in deeper holes with high bottom hole temperatures. The site of this well was considered to be suitable from the viewpoint of the absence of lost returns zones as well as the presence of a massive shale section which offered a good test of the non-dispersive character of the system.

At the time of conversion, the mud density was 9.7 ppg (72.5 pcf) and during the course of drilling was gradually raised to a maximum value of 11.2 ppg (83.7 pcf) at total depth. At this maximum mud density, the mud contained 29.3 weight percent light solids (sp gr — 2.6) and 9.9 weight percent barite.

The API water loss was maintained at an average of about 6.5 cc from 4723 feet to total depth. This appeared to be a satisfactorily low water loss with respect to maintaining the hole in good condition. No oil was used in the mud throughout the test. Examination of the section gage log showed that the hole was maintained very closely to gage with no washouts. Further, the micrologs

TABLE 5

Description of Wells in Which Calcium Surfactant Drilling Fluids Were Field Tested

Well	Location	Conversion Depth, Feet	Total Depth, Feet	Water Loss Agent
A	Louisiana	4723	9,695	CMC
B	South Texas	4715	12,512	Polyacrylate
C	Louisiana	5200	13,487	CMC
D	South Texas	8500	19,060	CMC
E	Louisiana	9200	16,354	CMC

TABLE 6

Drilling Fluid Properties at Various Depths in Well D

Depth (Ft.)	Viscosity (Sec.)	MUD DENSITY (Lb./Gal.)	MUD DENSITY (Lb./Cu. Ft.)	Plastic Viscosity (cp)	Yield Point (Lb./100 Ft²)	GEL STRENGTHS Initial (Lb./100 Ft²)	GEL STRENGTHS 10-Min. (Lb./100 Ft²)	30-Minute Water Loss (cc)	Resistivity at 77° F. (ohm-m)
8500	39	12.2	91.3	25	0	1	3	8.1	1.85
9000	52	13.2	98.7	30	14	2	23	6.5	1.90
10000	58	14.2	106.2	29	26	8	50	6.2	...
11000	67	17.1	127.9	62	31	4	36	4.2	2.30
12000	63	17.1	127.9	67	27	3	40	4.0	...
13000	53	17.0	127.2	50	23	4	32	5.5	...
14000	57	17.0+	127.5	66	21	3	25	5.8	...
15000	55	17.1	127.9	60	19	2	21	7.0	2.88
16000*	55	17.1+	128.3	57	17	2	17	5.0	...
17000	54	17.3	129.4	52	16	1+	6	6.0	3.06
18000	60	17.8	133.1	75	17	1+	5	4.5	...
19000	45	17.8	133.1	43	10	2	7	8.0	...

(Conversion to Calcium Surfactant Drilling Fluid at 8500 Feet).
* Intermediate casing set at 15,500 feet.

* Total calcium sulfate content was measured by dissolving excess in water and deterning total calcium ion therein by the versenate method.[17] The concentration of surfactant in the filtrate was determined colorimetrically with Marquis Reagent.[18] A simple pilot test may also be used to indicate the presence of sufficient surfactant, since water loss reduction by addition of surfactant is possible when it is deficient.

showed very little filtrate invasion and the presence of a very thin filter cake. All of this evidence suggests that the downhole water loss from this type mud was better than the API water loss tests would indicate.

Improvements in drilling rate and bit life were observed by comparison with the several offset wells (in which oil emulsion muds were not used). This was attributed to a lubricating effect of the surfactant mixture. However, in later tests conclusive evidence of these improvements was not observed probably because of the use of oil emulsion muds in offset wells. Although only limited information is available on this factor, it appears that the surfactant itself in the absence of oil can contribute many of the advantages that emulsified oil provides in conventional muds.

Well B: An anionic polymer of the acrylate type has been demonstrated to behave as a water loss agent with much better temperature and bacterial stability than CMC. Accordingly it was used in a second field trial of the calcium surfactant drilling fluid. Laboratory data had shown that a higher concentration of this material was required to produce a given water loss. However, rheological properties measured at room temperatures after aging had been carried out at elevated temperatures, were equal or superior to those of similar surfactant systems treated with CMC. Despite higher initial requirements in a field system, over-all cost of this type of material was expected to be lower because of decreased maintenance requirements.

In the actual field use of this water loss agent, it performed satisfactorily to a bottom hole temperature of 160° F. Above this temperature, gel strengths down-hole were sufficiently high to retard the lowering of logging tools. These gels were entirely reversible and were not apparent under surface conditions. In order to maintain the drilling fluid so that drilling could be continued, combinations of CMC and the polyacrylate were used to control water loss.

Although some difficulty was experienced in gel strength control, over 2000 feet of 5½-inch liner was run successfully in 6⅜-inch open hole and circulation was established behind the liner during cementing operations. This may be considered indicative of a stable true-to-gage hole and good down-hole drilling fluid properties.

Well C: This field trial differed from the previous two trials in that it was carried out in a rank wildcat and was projected to a greater depth. CMC was again used as water loss agent since no other materials showed promise of improved performance in intervening laboratory tests. The actual performance of CMC in this field was entirely satisfactory since bacterial degradation was virtually eliminated by the use of a preservative and temperature degradation was not a factor (maximum bottom hole temperature was 240° F.).

Hard rock drilling was encountered below the depth at which intermediate casing was set so that the water required for diluting light solids picked up in drilling was minimized. Filtration losses were also necessarily low since the amount of open hole was small, and addition of water to the system consisted almost entirely of that amount required to replace evaporation losses. Therefore, in the course of drilling this section it was possible to determine minimum maintenance requirements of additives used in the calcium surfactant drilling fluid. These requirements were as follows: 100 pounds calcium sulfate, 50 pounds CMC, 80 pounds P-30, and 15 pounds preservative per day.

Well D: Initially projected to a depth of 18,000 feet, this well was ultimately drilled to 19,060 feet. Conversion to the calcium surfactant drilling fluid was made at 8500 feet and from conversion depth to total depth all drilling was in prolific mud-making formations. Numerous previous attempts to drill through these shales had been made in this area without success. In addition, an average temperature gradient of about 1.8° F./100 feet exists in this area. The maximum bottom hole temperature as measured during electrical logging operations was 401° F. at 19,055 feet. The actual formation temperature is probably as much as 20° F. higher than this value.

The effect of temperature on the stability of the components of the calcium surfactant drilling fluid was negligible up to 350° F. Above this temperature, CMC degradation became significant and was considered to be very serious at total depth when the temperature was 401° F. All other materials were unaffected, even at the maximum temperature.

Despite the maintenance of higher water losses than normally used in deep drilling with conventional water base drilling fluids, excellent down-hole performance was observed in drilling in the Vicksburg and Jackson shales. The use of 10 volume percent diesel oil in the drilling fluid below 10,400 feet enable the API fluid loss to be maintained with reduced CMC requirements. When high temperature degradation of CMC became pronounced, water losses of the drilling fluid off bottom after bit changes and logging (usually close to 24 hours without circulating) were in the range of 20 to 30 cc. Even subjected to water losses of this order of magnitde the condition if the hole was satisfactory as evidenced by the absence of reaming required before drilling was resumed.

The drilling fluid off bottom after bit changes, exposed to temperatures in excess of 300° F. for up to 24 hours, always had a lower funnel viscosity at the surface than before it was circulated down-hole. This may be attributed to partial degradation of CMC

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Burdyn

L. D. Wiener attended Vanderbilt University from 1942 to 1946. He received his B.E. and M.S. degrees in chemical engineering from the University of Cincinnati in 1949. He also received his Ph.D. in chemical engineering. Employed at Magnolia Petroleum Company, Field Research Laboratories in the Drilling Fluids group since 1949, his present title is senior research engineer.

Ralph F. Burdyn was graduated from New York University with a B.S. degree in 1939 and M.S. degree in 1941, both in chemical engineering. He served four years in the Air Force. He attended The University of Texas Graduate School and received his Ph.D. in chemical engineering in 1949. Burdyn joined the Field Research Laboratories of Magnolia Petroleum Company in 1949. His work has been in the field of drilling fluids and cements in the position of senior research engineer.

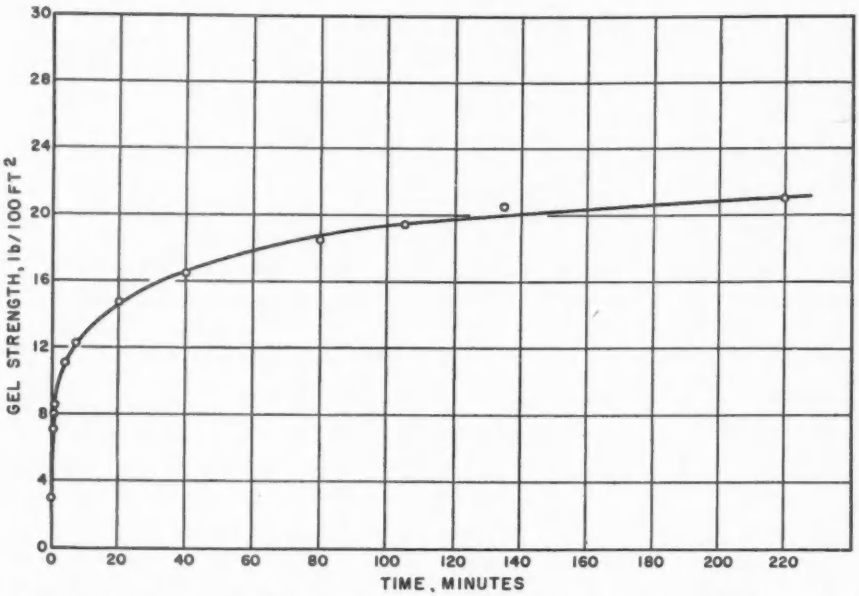

FIGURE 3—Gel strength build-up surfactant field mud. Note the rapid build-up of the gel strength initially and then the flattening of the curve. This gel-strength characteristic is desirable in that cuttings and weighting material are held in suspension effectively at relatively low viscosity.

and the absence of cementation reactions. There was never any difficulty in running logging tools to bottom.

At 15,500 feet a string of intermediate casing was easily run to bottom with no tight hole encountered. Circulation was established behind the casing and a successful cement job was obtained on the first attempt.

Well E: This well was drilled in an area where in the past serious difficulties have been experienced in maintaining drilling muds. Excessive conditioning due to high temperatures, as well as rapid solids build-up while drilling mud-making shales, have been the major problems. The latter difficulty has imposed limitations on the drilling rate in these shales.

The calcium surfactant mud has shown up to good advantage in drilling a soft gummy shale section between 9,200 feet and 14,500 feet. By virtue of its high tolerance for drilled solids in addition to being able to maintain treating chemicals (aggregants) in large excess, it has been possible to drill this section in one-half the time with half the number of bits required on the offset wells. Savings in rig time, bit costs and mud costs have reduced over-all drilling costs.

As was the case in the previous wells in which the calcium surfactant mud was used, the 10-minute gel strength was maintained at relatively high values in comparison to comparably weighted lime muds. This is feasible in the calcium surfactant mud because of the type of gel build-up that occurs when the mud is at rest. Figure 3 is a typical gel build-up curve obtained for the mud in Well E. It will be seen that there is a rapid gel build-up initially. Beyond this initial build-up, the slope of the curve decreases sharply and becomes essentially flat. Evidence of lack of down-hole gels has been shown by ease of running logging tools and by relatively low pressures required to break circulation. A gel build-up curve of this type is very desirable in that cuttings and weighting material are held in suspension effectively at relatively low viscosity.

Other Surfactant Muds. The use of CMC as the water loss agent in the calcium surfactant mud places a temperature limit of 350° F. on the mud from an economic standpoint. Above this temperature, the use of the much more stable (and readily available) polyacrylates is indicated; however, they should be used in systems containing only monovalent cations (such as sodium). A surfactant system of this type may be prepared by a "reversion" of the calcium surfactant mud to a low sodium system (0.5 to 1.5 percent sodium chloride). This can be accomplished in a well by discontinuing additions of calcium sulfate to reduce the excess to zero, and by converting the clays to sodium clays by the addition of sodium carbonate. Although this system is not as highly inhibited as the calcium surfactant mud, it should prove satisfactory at the depths it will be used since the formations are more consolidated and have less mud-making tendency. Desirable logging properties are retained by limiting the sodium chloride content.

Other applications of surfactants in control of drilling mud properties include sea water and saturated salt-surfactant systems. As in the calcium surfactant mud, CMC should be a satisfactory water loss agent to a temperature of 350° F. Above this temperature it will be desirable to use a polyacrylate.

The fact that surfactant muds are independent of ionic environment serves to demonstrate their versatility for field applications. For example, with the same combination of surfactants, it is completely feasible to change from one type of electrolyte to another in drilling a well, in completing a well, or for use as a behind-the-packer fluid.

ACKNOWLEDGEMENT

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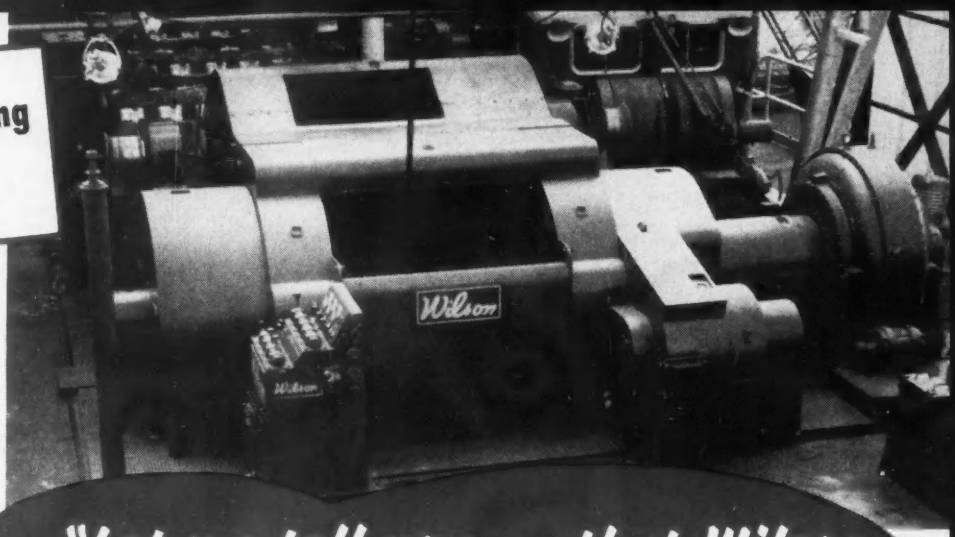
ilson Titan "66" rig on drilling latform "Carter Mart."



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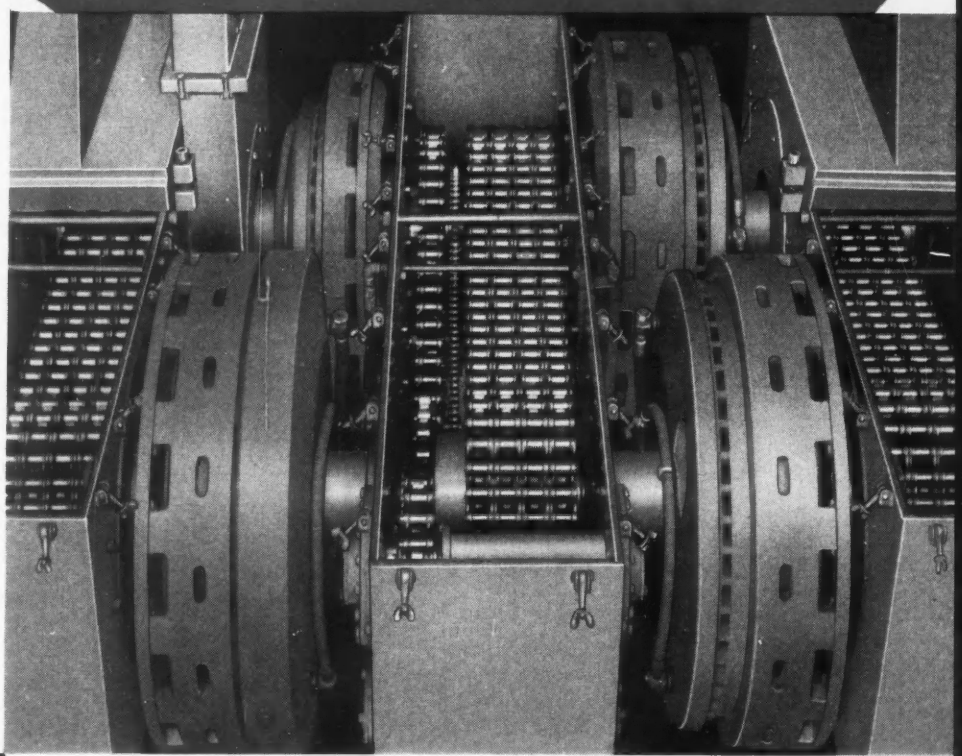

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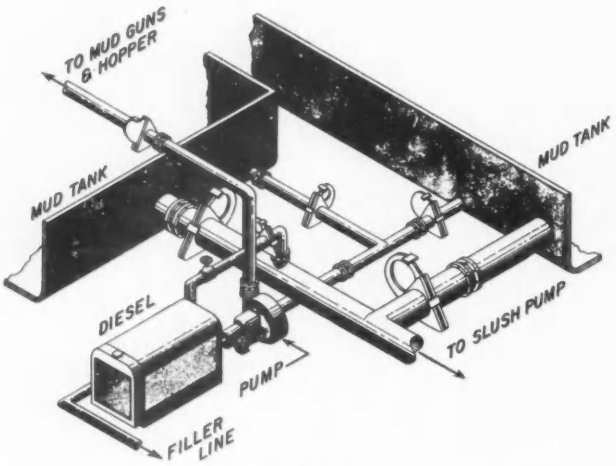

FIGURE 1

Drawing at left shows low-pressure-high volume mud system fitted with low pressure connections. It can be used to agitate the tanks, mix mud, fill up the hole, circulate the kelly in the mouse hole, and supercharge the mud pump action. The 50-hp diesel and centrifugal pump are shown in foreground of photo at right. Low pressure manifolding for the mud mixing system is shown in background.

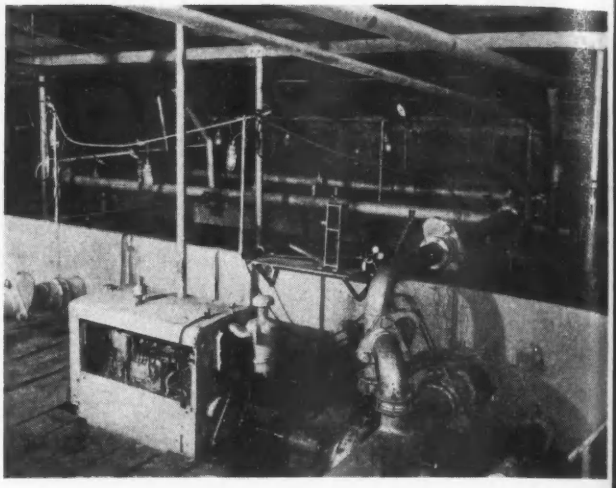

FIGURE 2

What can be gained by using . . .

Low Pressure-High Volume Mud Mixing Systems?

Mixing, agitation, fill-up and pump priming can all be accomplished with this low cost installation.

By L. W. Wooldridge and **Stan P. MacKay**
Imperial Oil, Ltd., Calgary

A LOW PRESSURE-high volume mud mixing system using a diesel-engine-driven 6-inch centrifugal pump and large-diameter, lightweight manifold system, is yielding substantial savings in operating costs. On one rig, total actual maintenance costs for a six-months period of continuous operation amounted to only $60; compare this with the estimated $50 per day for operating conventional high-pressure equipment.

Proper control and maintenance of drilling mud is essential in rotary drilling. Mud requires close attention at all times. Additions of bentonite, treating chemicals and often barites must be made regularly, in order to maintain a stable drilling fluid. Efficient agitation of drilling mud is often overlooked as a most important factor in drilling mud control.

It is especially difficult to maintain and control drilling mud on rigs equipped with only one pump. It is necessary on these rigs to drill and mix mud simultaneously. When circulation is split in this manner, the penetration rate is reduced and only minimum agitation is possible. The degree of agitation is often critical when it is necessary to convert to special muds.

Rigs equipped with two pumps can normally mix mud satisfactorily. However, the use of a 400- or 500-horsepower slush pump to mix mud is not economical or good mechanical practice. Maintenance costs on high horsepower slush pumps can exceed $100 per operating day. In most cases this cost is greater than the cost of the mud itself. When a standby pump is being used to mix mud, it is not always efficiently maintained for emergency use. Wear on fluid end parts while mixing mud is more acute than is normally realized.

Low pressure-high volume mud mixing systems (Figures 1 and 2) are being used on Imperial Oil Limited's company rigs to overcome these problems successfully. This technique should have wide application in Canadian drilling operations for rigs with one, two, or three-tank mud systems.

Low Pressure Manifold. A 50-horsepower diesel engine is coupled directly to a 6-inch centrifugal pump. This system is capable of delivering 1200 gallons per minute at 50 pounds per square inch. Mud is discharged from the centrifugal pump into a 6-inch low pressure manifold system

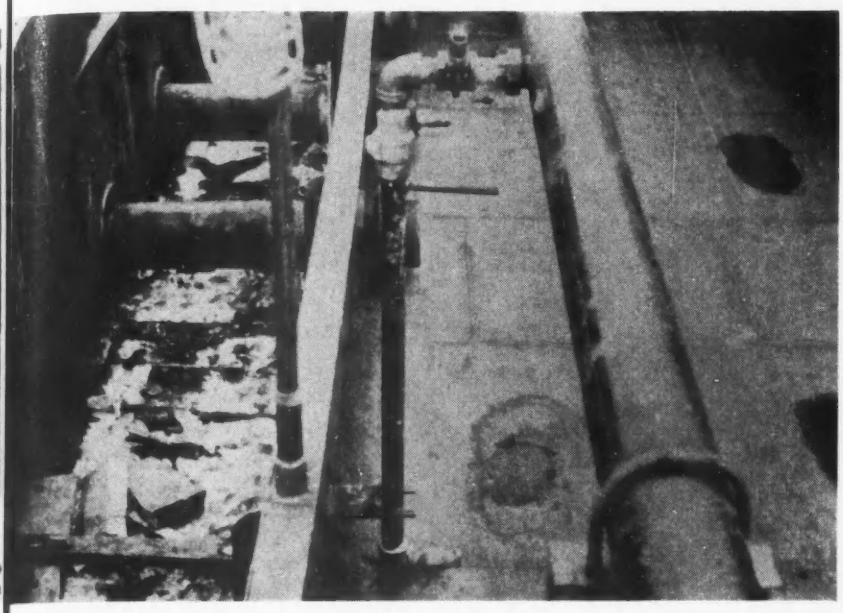

FIGURE 3—Interior view of an empty mud tank showing low pressure connections and gate valve for the bottom tank mixing guns. The 10-inch long rod welded to the two-inch vertical part of the gun is to rotate the gun manually for mixing and cleaning tank bottom.

which runs the length of each mud tank. Along the 6-inch manifold in each mud tank are three bottom tank guns (Figure 2) which can be manually turned to agitate any part of the mud tank. Surface guns can be attached to the manifold in each tank for mixing bulk lost circulation material. The guns are made of low pressure fittings (Figure 3). Each gun is connected to the manifold with a 2-inch union so that it can be taken out for repair. On each gun is a 2-inch clip gate valve and a low pressure rotating joint. A handle is welded to the rotating joint to facilitate turning of the mud gun. At the bottom of the gun is a 2-inch ell into which is screwed a 2-inch by 6-inch nipple.

The mud mixing unit (Figures 4 and 5) consists of a horizontal circular manifold of 2-inch pipe about 18 inches in diameter. Fourteen half-inch nozzles are spaced around the bottom of the 2-inch manifold. These nozzles are set so that the mud coming from the nozzles will converge at a point about 18 inches below the circular manifold. A hopper extends downward from the circumference of the 2-inch circular manifold and converges to a bottom opening about 8 inches in diameter. The vertical height of the hopper is 20 inches. Above the mixing manifold is a second hopper with an adjustable bottom orifice through which dry bentonite may be sifted into the mixing hopper. The upper hopper is vibrated by an eccentric. Power is supplied to the eccentric by a ⅓-horsepower electric motor.

Costs Reduced, Safety Improved. The low pressure-high volume system is very flexible in its operation. With this system it is possible to mix mud, agitate the mud tanks, keep the hole full while tripping, charge the suction of the slush pump and circulate the kelly in the rathole to prevent freezing while making a trip. It can also be used to supply large volumes of mud or water for cementing.

The system eliminates a high pressure mud mixing manifold and thus contributes to personnel safety around surface mud mixing equipment. There have been many accidents and some fatalities as a result of the failures of mud line fittings under high pressure.

Many other advantages of this equipment are evident. For example, standby slush pumps may be maintained for emergency use only. The total cost of this equipment, including power, pump, and manifold, is less than the cost of the high pressure mud manifold alone, that is required in a high-pressure system with three mud tanks. Maintenance cost for a period of six months continuous operation was only $60 total, as compared to an estimated cost of $50 per day for operating a slush pump. On one pump rig the total volume output of the slush pump may be circulated through the hole when it is necessary to convert to special muds. Mud tank bottoms are always clean. Sand and silt sludge are settled out in a long settling ditch which is an integral part of the system.

—The End

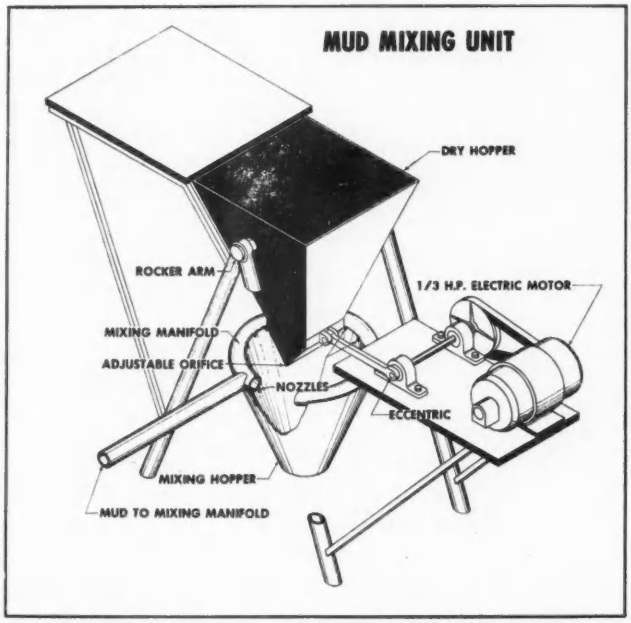

FIGURE 4—Low pressure mud mixing equipment. Dry hopper has adjustable hopper for regulation of continuous mixing.

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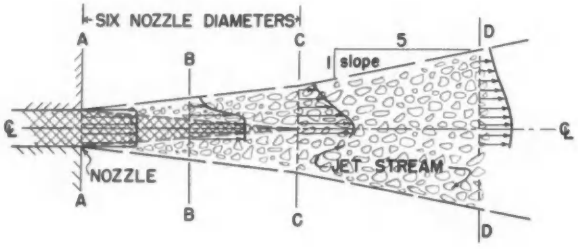
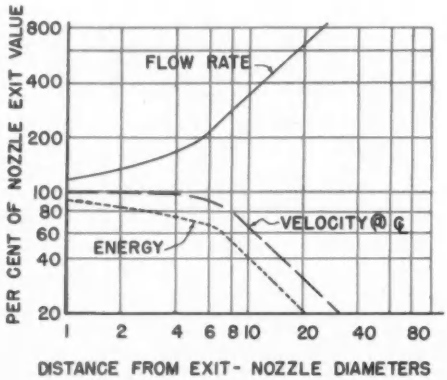
Stan P. MacKay is a drilling engineer with Imperial Oil Limited. He graduated from the University of Oklahoma with a B.S. degree in petroleum engineering in 1950. Upon graduation he joined the Magnet Cove Barium Corporation and was a mud service engineer in Western Canada until early in 1955.

Part 5C

Keys to Successful Competitive Drilling

FIGURE 30—Conventional bit (top) and jet bit (bottom). Note the difference in the fluid stream directed toward the bottom of the hole.
CourtesyHughes Tool Co.





FIGURES 31a (top) and 31b (bottom).

A series on modern drilling technology—rotary hydraulics and some of the variables that contribute to the successful use of jet and conventional bits.

By Roy A. Bobo and Robert S. Hoch
Drilling Engineering Department
Phillips Petroleum Company, Houston

Flow Pattern Below Bit. From the discussion in the preceding issue, one should realize that the cleaning job that must be performed by the drilling fluid exists close to bottom-hole surface. It is also important to understand how the fluid velocity and energy conditions in the space below the bit exists influences the velocity conditions close to the bottom-hole surface.

The flow pattern below a conventional bit having drilled water courses is considerably different than that below a jet bit that has insert-type nozzles. The fluid streams emerging from a conventional bit strike the top of the bit cones and are deflected toward the side of the hole with only a small portion of the fluid energy being directed to the bottom-hole surface. However, in jet bits, due to the position of the nozzles, the jet stream is directed to the bottom-hole surface. This difference in flow pattern is illustrated in Figure 30 which shows fluid circulation through the two types of bits operating in an air atmosphere. In this difference lie the advantages of using jet type bits.

The profile of a submerged jet stream is similar to that shown in Figure 30, except that it has a greater flare. The reason for this is that the high velocity stream, emerging from the nozzle, accelerates and entrains the surrounding fluid. This is illustrated in Figure 31a, which shows the velocity distribution across the jet stream at various distances from the nozzle exit. The cross hatched area in Figure 31a represents that portion of the stream having the original exit velocity. The solid line in Figure 31b shows the total fluid flow rate at various distances from the nozzle exit. At a distance of six nozzle diameters, the flow rate has doubled. This means that for a 400 gpm pumping rate, the jet stream rate close to the bottom-hole surface will exceed 800 gpm. Figure 31b also shows the percentage reduction in flow stream centerline velocity and total kinetic energy at various distances from the nozzle. Observe the rapid decline in velocity and energy at distances greater than six nozzle diameters. The total impact value (QV) of the jet stream remains constant.

The foregoing data were from laboratory tests of submerged jet streams in infinitely large volumes. The literature contains little concerning characteristics of submerged jet streams in small confined spaces. Eckel and Bielstein[14] presented data showing a more rapid decline in center line velocity than is indicated in Figure 31b. Also, the

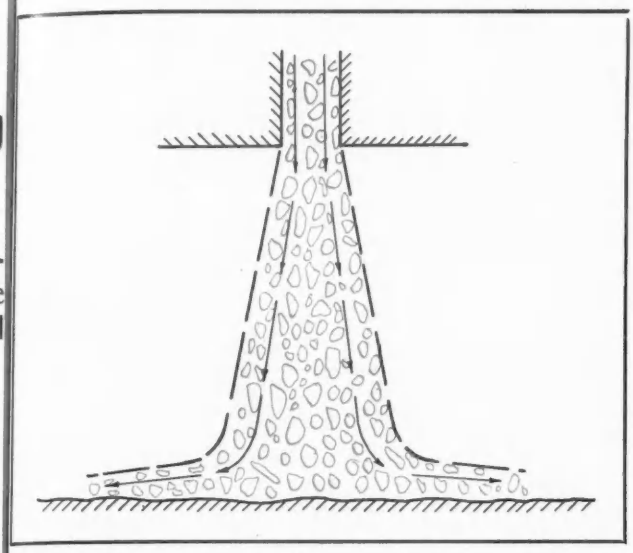
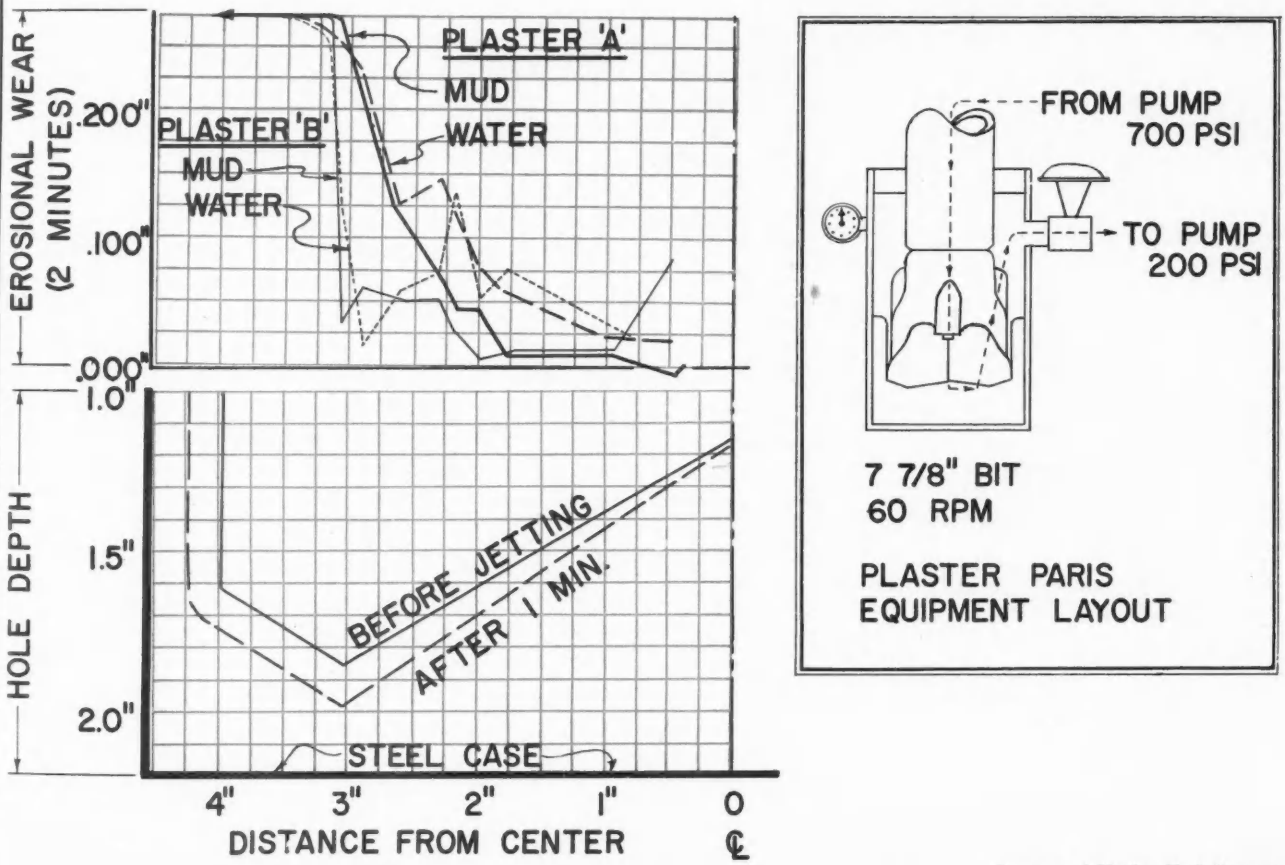


FIGURE 32—Submerged jet stream impinging against flat surface.

total impact value of the jet stream decreases with increasing distance from the nozzle exit at a more rapid rate when confined by the well bore.

The jet stream is deflected in directions parallel to the drilled surface as illustrated in Figure 32, then upward into the drill collar annulus. The average velocity of this deflected stream decreases rapidly at increasing distances away from the point of deflection. This is illustrated in Figure 33, which shows the amount of fluid erosion on a pattern made by a bit on a plaster of paris surface. This erosion was the result of high flow velocities and the hydraulic characteristics of the jet type bit. Observe that the erosion was least at the center of the surface, and greatest near the hole gage. Also note that the amount of erosion near the gage was about the same for both water and mud. However, in the center portion of the bottom hole surface, the water drilling fluid indicated the greatest erosion. This denotes that the viscous properties of the fluid also exert influence on the fluid velocity conditions close to the bottom of the hole.

Effect of Viscosity on Velocity at Bottom of Hole. The fluid velocity profile, at certain points along the bottom hole surface, may be similar to that shown in Figure 34. According to theory,[15] the velocity at the boundary (bottom hole surface) is always zero. For Newtonian fluids, a laminar flow layer exists adjacent to this boundary. In this layer, the velocity of the fluid stream increases in direct proportion with distance from the surface. For this reason, the surfaces of larger particles are subject to higher velocities than the smaller particles. The velocity at any point within this low velocity region can be calculated for flow in smooth walled pipe. This in no way duplicates the velocity condition that exists at the surface below the bit but it does indicate those factors which influence the velocity conditions close to the boundary surface where the job of cutting removal must be performed. The following equations



Courtesy of Hughes Tool Company

FIGURE 33—Jet erosion on a plaster cast (water and mud).

are derived and are for a 9 pound per gallon mud flowing through smooth pipe with a friction factor of .004.

$$Vy = \frac{4.08\ y\ Vavg.^2}{\mu} \quad (13)$$

$$t = \frac{.061\ \mu}{Vavg.} \quad (14)$$

Vy = Velocity at y-ft/sec.
y = Distance above boundary—inches
μ = Fluid viscosity—centipoises
Vavg. = Average velocity of flowing stream ft/sec.
t = Thickness of Laminar layer—inches

This equation suggests that the velocity of the fluid at any point (y) within the laminar sublayer can be increased and the thickness of this low velocity region can be reduced by either increasing the average velocity of the fluid stream or by decreasing the viscosity of the fluid. At this time, the combined effects of yield value, plastic viscosity and average flow stream velocity to the velocity gradient adjacent to the boundary surface is not known. In view of the fact that plastic viscosity and yield value are both flow-resisting components, an increase in either or both values will probably tend to reduce the velocities close to the bottom hole surface in the same manner as indicated for Newtonian fluids.

For a roughened boundary surface, such as exists below a bit, the high points, or the hills, will often extend well into the turbulent flow region and will be subjected to high fluid velocities approaching that of the average stream velocity. The velocity at any given distance above these high points would be much greater than that calculated from Equation 13. In the many low points, or protected valleys, the velocity condition at any point may also be greater than that calculated from Equation 13 when using low viscosity fluids. When bounded by a rough surface, these fluids tend to create turbulence and increase the velocity in the laminar sublayer. This tendency is illustrated in Figure 35, which shows two plaster of paris surfaces that have been exposed to equal jet stream velocities of water and mud. Observe the roughened surface on the plaster surface exposed to the water.

In conclusion, bottom hole cleaning action has reference to the fluid velocity condition close to the surface below the bit. This can be increased during field drilling operations by:

1. *Increasing the average velocity of the flow stream adjacent to the bottom hole surface. This can be accomplished by increasing the pump circulation rate, or by reducing the size of the bit nozzles, or both.*
2. *Reducing the viscosity of the drilling fluid.*

PUMP CIRCULATION RATE AND BIT NOZZLE REQUIREMENTS

The pumping rate and bit nozzle program are adjuncts to the basic factors which affect bit performance. The potential drilling rate is governed by the nature of the action of the bit teeth, depth of tooth penetration, and the effect of the fluid properties (density, viscosity, and filtration) on the volume of dislodged formation. The actual drilling rate and bit footage is then controlled by the percentage of this total dislodged rock that can be removed by the drilling fluid before being reground by the bit.

As previously stated, a particle will be moved away from the surface beneath the bit when the combined fluid removal forces exceeds the total force which holds

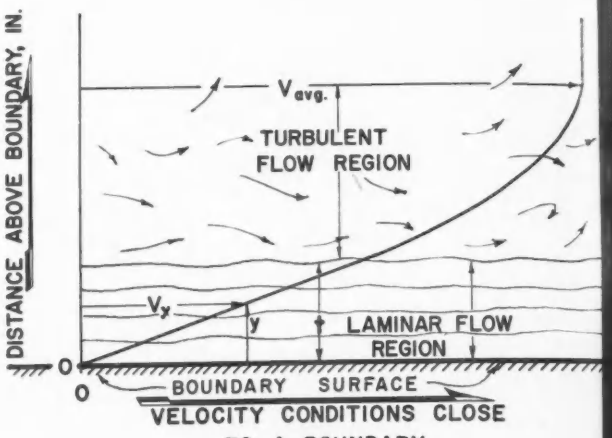


FIGURE 34

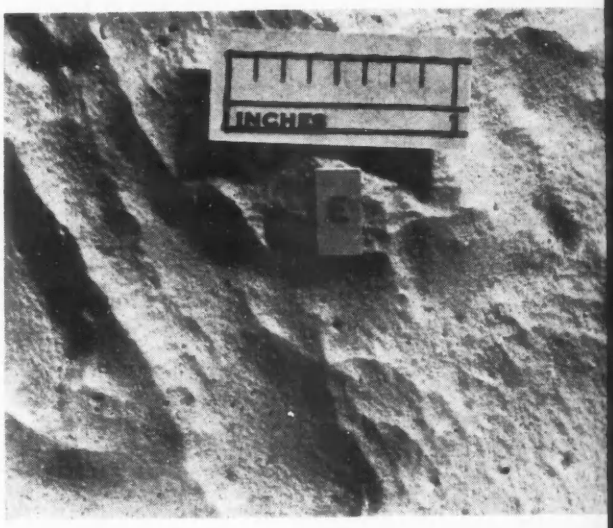
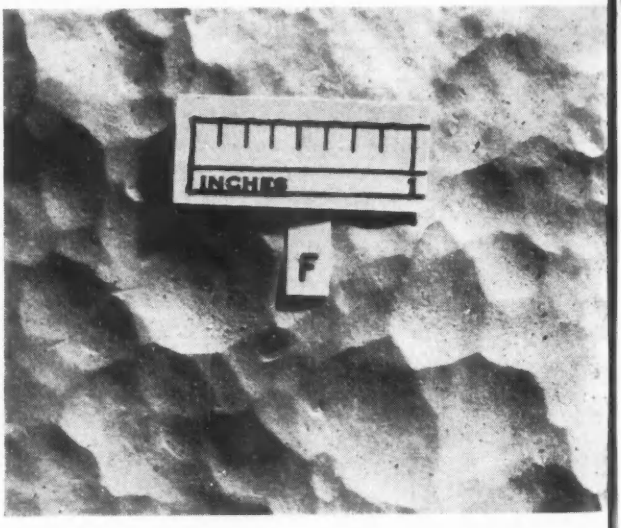
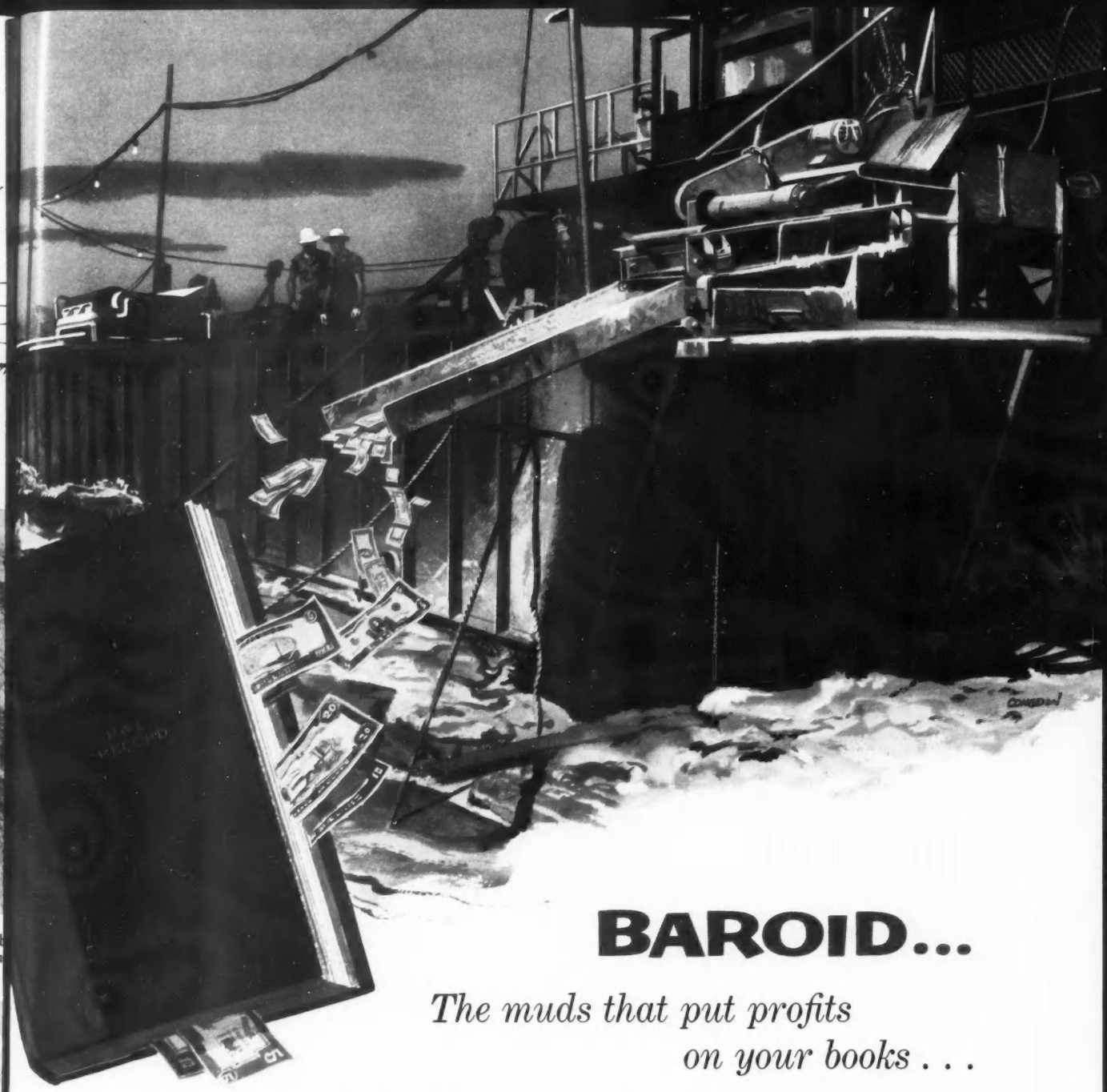


FIGURE 35—A comparison of plaster bottom hole surfaces subjected to the erosional actions of water (above) and mud (below) jet streams.



the cutting in place. These fundamentals indicate that relatively high velocities adjacent to the face beneath the bit may be desirable when drilling under the following conditions or combinations of conditions:

1. In the more plastic formations which tend to e



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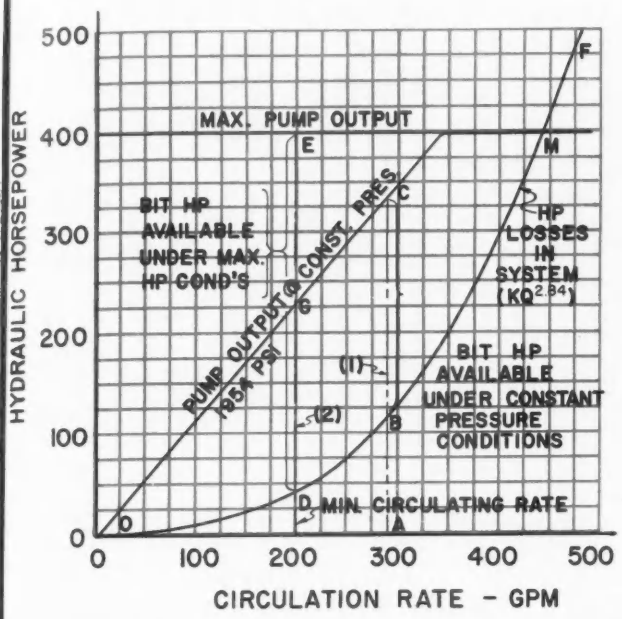

FIGURE 36—Comparison between minimum horsepower obtainable across bit jets for conditions: (1) Where applied surface pressure is limited (1954 psi), and (2) where no restriction is placed on applied pump pressure.

trude rather than produce chips under action of the bit teeth;

2. When high bit loads result in larger particles and increased drilling rates.
3. When the drilling fluid is of high density, high viscosity, and has low filtration properties;
4. When rotative bit speeds are extremely high.

The magnitude of hydraulic energy expended below the bit should also be based upon the costs of providing this energy. The added costs for delivering energy to the bit may limit the drilling rate to some value less than the potential rate that could be achieved with complete removal of the cuttings. Other factors such as equipment, policy, and personnel can also restrict the supply of hydraulic energy. For these reasons, an optimum rather than a maximum expenditure of energy should be the goal. The result will be attainment of the minimum drilling cost on reaching total depth.

The optimum pump circulation rate and nozzle size program can best be established by integrating those influencing factors previously discussed with experience, particularly that gained in drilling the first well in a given area.

Two theories have been advanced to relate the circulation rate and nozzle velocity to chip cleaning or particle removal. One group of investigators maintains that the attainable rate of penetration will vary with the impact produced at the bit nozzle, or to the product $Q_n V_n$. Others maintain that the horsepower expenditure of the jet stream below the bit which is proportional to $\frac{wV^2}{2g}$ or QV^2 controls the effectiveness of the cleaning action. Although impact and bit horsepower are the two terms currently used to designate cleaning ability, other factors such as the type and size of bit, nozzle shape and position, and properties of the drilling fluid also influence the chip removal by the fluid stream. When maintaining maximum jet horsepower with maximum pump output, the bit nozzle velocity will always be as high or higher than when operating at maximum bit impact. However, the circulating rates will always be equal to or lower than those for maximum impact operations. The authors prefer to treat the effects of jet action in terms of horsepower.

Jet Bit Principles. The effectiveness of the horsepower that is expended beneath the nozzles in sweeping away the material generated by the bit can only be determined in the field. However, a knowledge of the theoretical considerations concerning the jet process will greatly facilitate operation under those conditions that result in optimum performance.

Many drilling rigs are operating under self-imposed hydraulic limitations. Most often, the discharge pressure of the mud pump is limited for economy reasons to some fixed maximum value. The contractor who operates with a limited discharge pressure will not obtain rated horsepower output from his pumps at the greater depths. He also will be restricted on the amount of energy that is available for his bit jets.

Jet Bit Principles—Limited Pump Discharge Pressure. The condition for maximum horsepower expenditure across the bit nozzles may be approximated by assuming that all flow throughout the circulatory system is turbulent. Thence

Total Pump Horsepower = Bit Horsepower + Horsepower Loss in System.

$$HP_T = \frac{(GPM)\ P_d}{1714} = HP_{Bit} + \frac{K\ (GPM)^{2.84}}{1714} \qquad (15)$$

Where $K\ (GPM)^{1.84}$ = Pressure loss in drill pipe and rest of system exclusive of loss through bit = $P_{d.p.}$

$$HP_{Bit} = \frac{(GPM)\ P_d}{1714} - \frac{K\ (GPM)^{2.84}}{1714} \qquad (16)$$

For maximum conditions, with P_T constant,

$$\frac{d\ (HP_{Bit})}{d\ (GPM)} = \frac{P_d}{1714} - \frac{2.84\ K\ (GPM)^{1.84}}{1714} = O \qquad (17)$$

Whence $P_d = 2.84\ K\ (GPM)^{1.84} = 2.84\ P_{d.p.}$

$P_{d.p.} = .35\ P_d$

or $P_{Jets} = .65\ P_d$ or when: Bit HP = .65 Total Pump HP

Hence maximum horsepower across the bit jets in a system of limited pressure will occur when the pressure drop across the nozzles is 65% of the total pressure loss in the system. This remains true provided the major portion of the total pressure loss results from turbulent flow.

Figure 36 shows a plot of hydraulic horsepower versus circulation rate for a rig operating at a given depth under constant pump discharge pressure. The linear line O-C-M represents hydraulic horsepower developed by the mud pumps under such conditions. The curved line ODBM is a plot of horsepower losses in the drill string (exclusive of the bit nozzles). Point A corresponds to a circulation rate where maximum horsepower expenditure may be obtained across the bit nozzles. At this circulation rate, the power loss in the drill string is 35% of the total for the system.

Jet Bit Principles—Unlimited Pump Discharge Pressure. When the optimum bit horsepower is not known, or where the available rig horsepower is less than that required to provide the optimum bit horsepower, effort should be made to secure the maximum possible supply of jet energy. The way to do this is also illustrated in Figure 36. Here, the bit nozzle and liner sizes are selected in order to maintain fully loaded pumps at the *minimum* annular circulation rate, which in the example

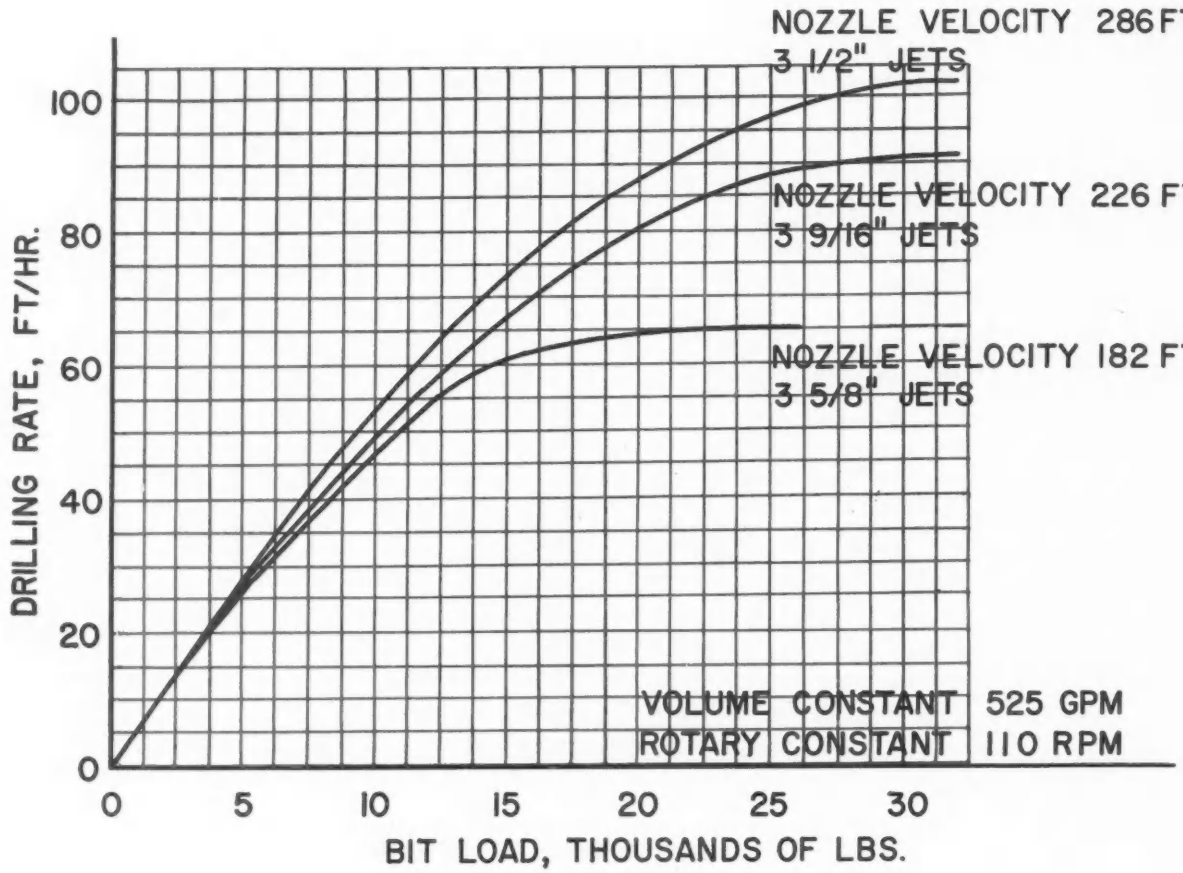

FIGURE 37

is 200 gpm (Point E on line ME) from the surface to total depth. In the case shown, ED represents the bit horsepower which will be available under these conditions.

Summarizing, a) *maximum available bit horsepower will be obtained for conditions of constant pump discharge pressure when the pressure loss across the bit jets is approximately 65% of the total loss in the circulatory system.*

b) *Maximum utilization of pump horsepower and maximum available bit horsepower will occur under the following conditions:*

1) *When the annular velocity is at a minimum permissible value, and the*
2) *Nozzles and liners are sized to load the mud pumps for full horsepower output, with no restriction placed on pump discharge pressure.*

Jet Bit Principles—Effect of Weight. The best drilling operations with jet bits will result from a balanced over-all drilling program, without over or under emphasis on pump circulation and bit nozzle requirements. For any given drilling fluid, the jet hydraulics must be tied in with weight and rotary speed. Application of weight in particular must be accompanied by planned hydraulics. Figure 37[15] is an example of the manner in which bit horsepower must be increased to permit increased bit loads, and consequently increased drilling rates.

Some Gulf Coast rigs, for example, economically utilize bit nozzle velocities in excess of 400 feet per second and hydraulic horsepowers above 400 when drilling a 9⅞-inch hole. The bit horsepower and nozzle velocity trend is upward for most rigs drilling in shaly formations. A major portion of the total footage drilled each year is in shales or shaly formations.

The advantages to be gained with high bit horsepower are considerably less for the more brittle type formations, such as the West Texas dolomites, cherts, and quartzites. These formations are generally drilled with clear water or an oil-water emulsion. One of the most prominent "high horsepower" contractors in this area* increases the bit horsepower to 200 at drilling rates above 60 feet per hour. For drilling rates less than 10 feet per hour, conventional bits are often used.

When drilling with air, all formations, including shales, are brittle. With 8¾-inch bits, less than 40 bit horsepower will generally provide adequate bottom hole cleaning energy for the highest drilling rates.

* When, during jet bit operations, the drilling rate of these type formations become less than 10 feet per hour optimum cleaning and bit performance can often be accomplished with conventional type bits.

ACKNOWLEDGMENT

The authors gratefully acknowledge the assistance and constructive suggestions of Henry Wood and W. A. Kistler of Hughes Tool Company, and to that company for some of the experimental work which was performed. Appreciation is also expressed to Dr. George R. Gray of Drilling Fluids Corporation for helpful suggestions, and to the management of Phillips Petroleum Company for permission to publish this article.

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Chapter 6 in the series on Successful Competitive Drilling entitled "Reduced Pressure Drilling," will appear in the December Issue of WORLD OIL.

The Theoretical Approach to Turbodrilling

The mechanical comparison of the turbo and conventional drilling methods indicates an increased possibility of the application of turbodrilling in industry.

By **W. Tiraspolsky,** Consulting Engineer
Bureau de Coordination Technique, Paris, France

THE PRESENT STATUS of turbodrilling is on the narrow demarcation line between a past and a future rich in possibilities. It is difficult to choose between the enthusiasm of the admirer and the distrust of the sceptic. To draw the conclusion that the turbine drills 10 times as fast as a rotary rig from a few experiments is of no more value scientifically, than to conclude from a few figures that turbodrilling is economical.

It may be said that turbodrilling is scarcely out of the cradle. Turbodrilling has more prospects of becoming a main branch of world drilling technique, than the rotary method had 25 years ago against the cable tool method.

Historical. In the U. S. and Europe there is a long history of turbodrilling. Much has been published on the American turbodrill experiments: the Sharpenberg turbine, which dates from as early as the Kapelyushnikov period, the Postlewaite turbine, and the Edco-drill.

In Europe, around 1925-28 the French engineer Lachamp, and his Swiss colleague E. A. Perret constructed a pipeless turbodrill installation. A turbine, with an expanding bit, was lowered and withdrawn, through the casing pipe, used as drill stem. Successful drilling experiments were carried out with it in Poland and later at Pechelbronn, France. At the same time Wirth & Company at Erkelenz, Germany, was engaged on the construction of prototype turbodrills in collaboration with Kapelyushnikov.

During World War II the Voith Company at Heidenheim, Germany, took an interest in drilling turbines. On the basis of data from this firm, a three-stage, 6.5 horsepower turbine with an outer diameter of 4¾ inches and a speed of 2200 rpm, and a two-stage, 9.25 hp turbine with an outer diameter of 8½ inches and a speed of 1500 rpm were built in this period. Both were provided with reduction gears and the drilling tests showed there was no gear which could stand up to the conditions in the borehole. The Voith Company designed a gearless turbine, with an outer diameter of 9⅛ inches, 45 stages, 31.5 hp and a speed of 300 rpm, that was not completed. Recently the Voith firm returned to the problem of turbodrilling. Some experiments have also been carried out in Yugoslavia since the war.

On January 6, 1956, the first modern turbodrill began to rotate in the St. Bauzille 1 near Montpellier, France. It was one of the two prototypes built in the Grenoble factories of the Neyrpic concern in 1955. These prototypes are still drilling.

Use and Manufacture of Turbodrill. There are only two manufacturers of turbodrills in the world: the Soviet government and the Neyrpic concern at Grenoble. The only Russian turbines in use in the western world are those in Austria. In France the two prototypes have drilled more than 10,000 feet in the south and west of France, North Africa and Holland. The record drilling time of these turbines between repairs is 171 hours. In hard formations, many times the rotary drilling penetration rates were attained. In all cases, as far as bit on bottom time is concerned, drilling proceeded as fast and usually faster than the rotary system. Recently these 10-inch turbines were put into quantity production. (These figures refer to the situation of October, 1956. More than thirty 10-inch and 7¼-inch turbines have been built in France and 7⅝-inch turbines are under construction. Russian and French turbodrills have been imported to the U. S. and Germany, and licenses to manufacture turbodrills have been issued in these countries.)

Part 1

The drilling expert has a wide choice of turbodrills ranging from the high mud rate 10-inch Russian turbine, with a flush consumption of up to 1270 gallons per minute, to the 5-inch turbines in normal use in the east.

If the driller wishes to turn to turbodrilling, he must know the main characteristics of these turbines, such as the power, rate of revolution and torque; he must be able to acquire a deeper insight into the character of this new technique. This is far from easy, for the turbines have progressed more than turbodrilling.

Application of Turbodrilling. The turbodrill has two main fields of application:

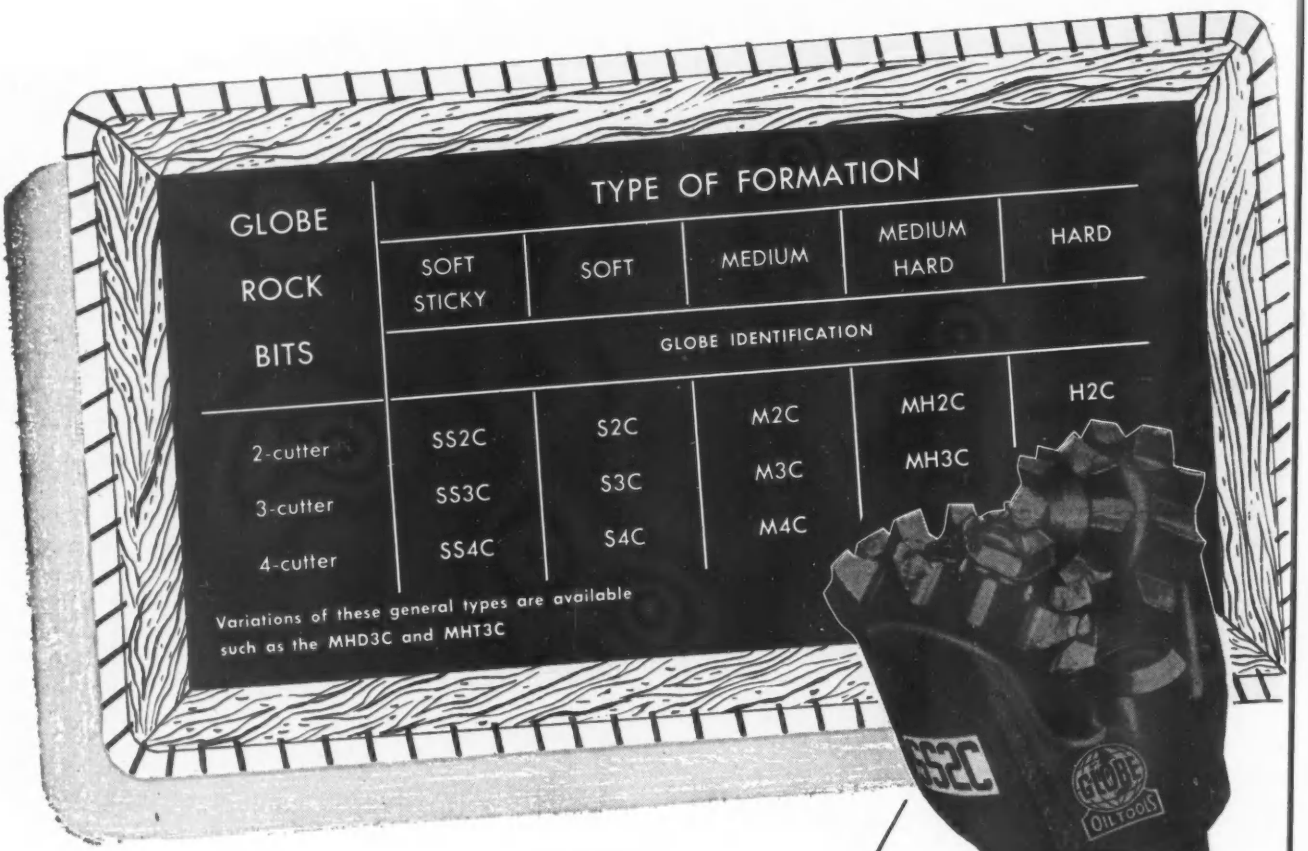
1. Achievement of better drilling.

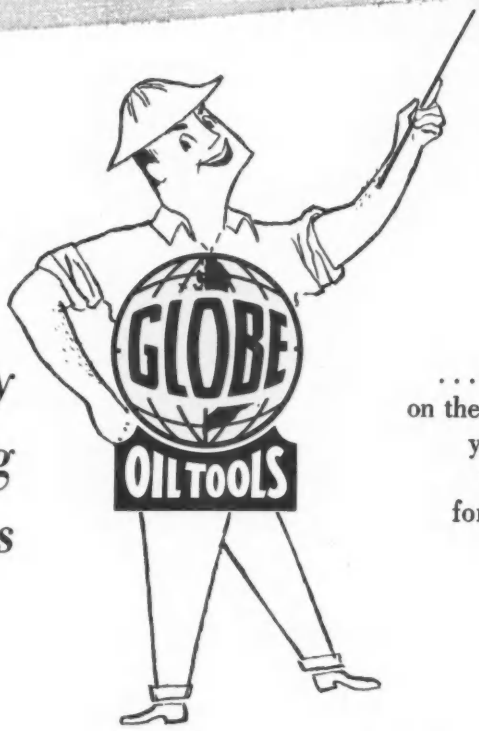
2. Controlled drilling by other than conventional methods.

Better drilling means quicker or cheaper drilling, or both. As the characteristics of the various drilling methods are analyzed, it is apparent that the main factor in drilling is the specific power transmitted to the bit. Specific power is the power per unit section of the hole drilled. For measurement the number of horspower per square inch is suitable for normal borehole dimensions. If P is the useful power of a turbine expressed in horsepower and D the bit diameter in inches, the specific power (P_{sp}) will be:

$$P_{sp} = \frac{P}{\frac{\pi D^2}{4}} = 1.27 \frac{P}{D^2} \text{ hp/sq. in.}$$

In Figure 1 the abscissas represent the bit diameter in inches and the ordinates represent the specific powers





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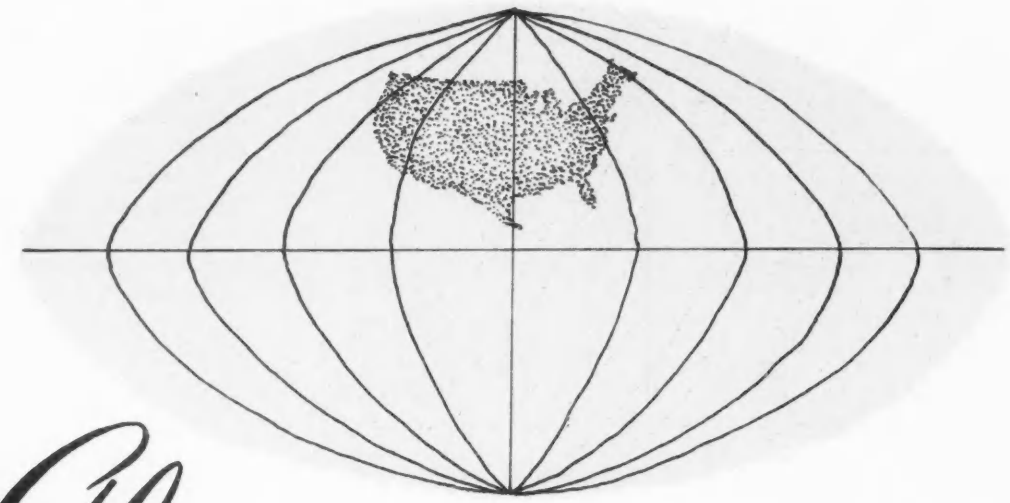

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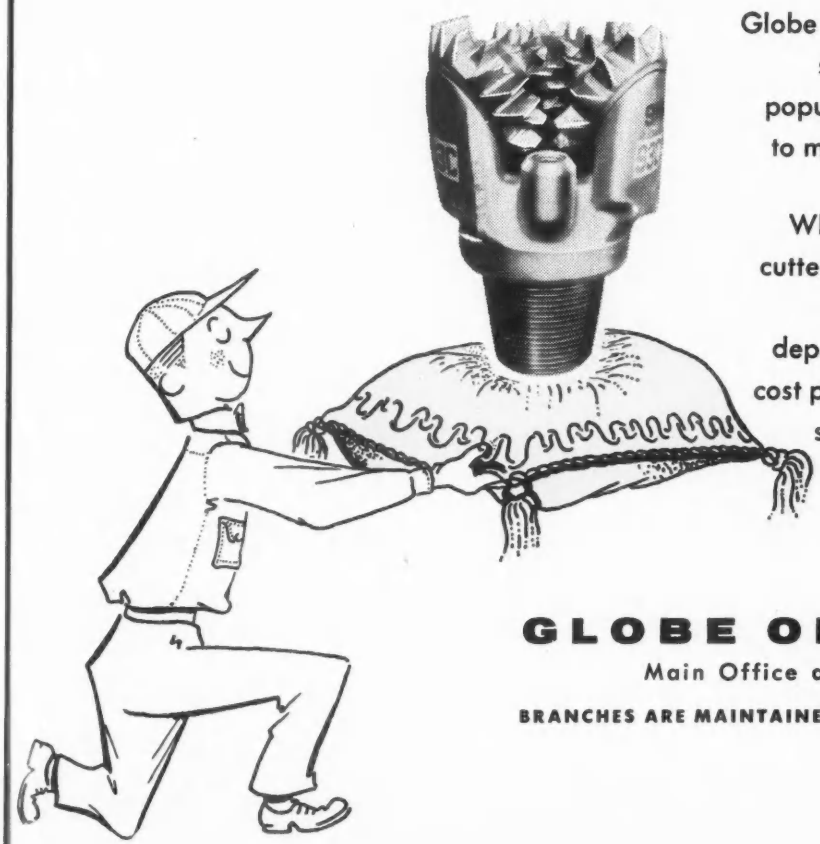

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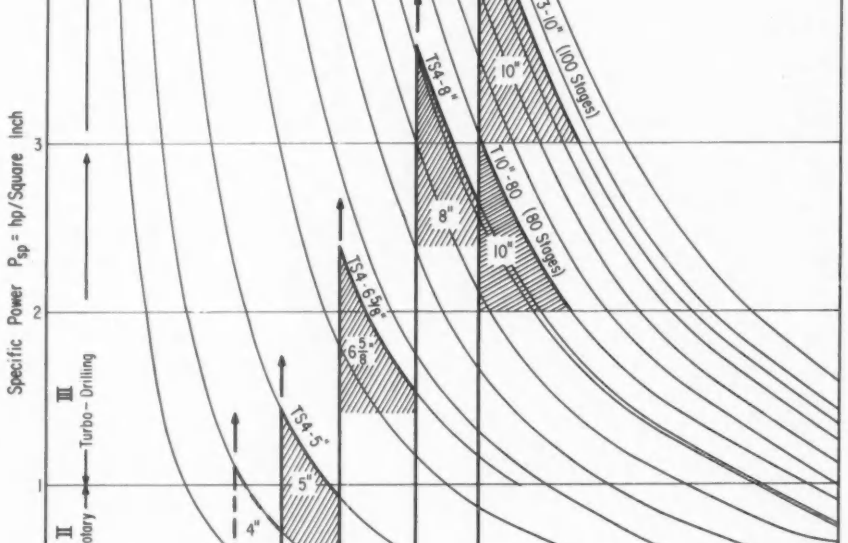

FIGURE 1—Bit diameter as a function of specific power. Curves show course of specific power for different bit diameters and turbine outputs, ranging from 10 to 500 hp. Low power range (Zone I) corresponds roughly to cable drilling; power rotary is in Zone II and above that is turbodrilling range.

of the modern Russian and French turbines. This series of curves shows the course of the specific power for different diameters and turbine outputs, ranging from 10 to 500 hp. The lower (zone "I") corresponds roughly to cable drilling. Rotary drilling extends roughly between 0.2 and 1 hp per square inch (zone II). Above that, between 1 and 4 hp square inch, is the field of underground engines. The power which can be transmitted to the bottom of the hole in rotary drilling has been widely discussed. American drilling experts are critical of the European drilling methods and consider them unequal to their own. That is not completely unjust. Except for the special field of jet bit drilling, American drillers achieve rates of penetration many times higher than our own. American drillers are known to put weights as high as 80,000 pounds and more on an 8¾-inch bit. The rate of revolution attained is never higher than 60 rpm. In hard formations this may be regarded as one of the best performances of American drilling. How many horsepower does that represent at the bottom of the hole? In rock hard enough to bear such rates, the specific torque resistance of the bit will not exceed 35 foot-pounds per 1000 pounds of weight. Using 35 foot-pounds, 60 rpm and 80,000 pounds the power *(P)* on the bit is:

$$P = \frac{2\pi 60(35)\ (80)}{33000} = 32 \text{ hp.}$$

This is high for rotary drilling, but is short of 150, 200 or 250 hp, which might be brought to the bottom of the borehole, by means of a turbine.

In Figure 1 the zones of application of the various Russian turbines from 10-inch to 6⅝-inch and of French 10-inch rotary turbine are cross-hatched. The 4-inch turbine, not yet beyond the experimental stage, is shown by a dotted line. On this diagram we see that the specific power, for the 10-inch and 8-inch turbines exceeds the possibilities of rotary drilling, and gets smaller as the bit diameter decreases. There are structural reasons for this, which are difficult to overcome. It is impossible to reduce proportionally the wall thickness, the tolerances, the blade thickness and shaft diameter, as the external diameter decreases. At present the drilling turbines have to rely on bit sizes in the 8-inch and 18-inch range. In Figure 1 the possibilities of further development of the turbine are indicated by arrows.

Russian technicians have made a jump forward with the introduction of their double turbines (sectional turbines). From the data published on Russian turbodrilling and the analysis of the data collected on French 10-inch, 80-stage turbines, it can be stated; that in every case where, an appreciably higher power was transmitted, to the bit by the turbine than was possible with the rotary, drilling proceeded more rapidly. In some cases the turbine drilled much faster because no load could be placed on the rotary bit due to the risk of borehole deviation. In some cases the turbine drilled much faster, because the drill stem was so overfatigued that the rotary table could not be made to rotate fast enough. These cases do not prove that, in other circumstances, or with better equipment, drilling would not have been better by the rotary method. They have proved that the turbine was more economical in such cases. Theoretical investigation has shown that turbodrilling is cheaper than rotary drilling in cases where time saved by faster drilling is more valuable than the extra cost of turbodrilling. Often in deep drilling, a day's drilling costs $1500, not counting direct drilling expenses. The average penetration rate with rotary drilling is not more than 75 feet per day. At this rate each foot bears a fixed cost of $20. If the turbine enables the average drilling rate to be raised, from 75 to 150 feet and assuming that direct costs (excluding turbine depreciation) are the same for both methods, then $10 is saved on each foot drilled. If the average penetration rate is increased by only 50 percent, there is still a saving of $6.67 per foot, which is sufficient to pay for the conversion from rotary to turbodrilling. In all cases where the speed

or load transmitted to the bit with a rotary installation is limited, and the highest possible drilling penetration is not being attained, the change-over to the turbine means an increased drilling rate, often many times the normal drilling rate.

When comparing the turbine with various rotary techniques one should bear in mind that the turbodrilling system must have reached a stage of technical development equivalent to that of the rotary technique, with which it has to compete. Comparison of the turbodrilling process and rotary process is valid without question in hard and medium-hard formations. The case is somewhat different in soft formations.

In Russia, turbodrilling was a universal method in the Ural fields by about 1950, it took five more years before the same method could be applied in the far softer formations of the Caucasus. The invention of the slower and more powerful, coupled turbines, enabled this difficulty to be overcome. In western engineering it will be more difficult, as far as penetration rates are concerned, to extend turbodrilling to this field than has been the case in Russia. Western drilling has been a revolutionary advance in soft formations with the introduction of the jet bit. It is fruitless to make an economic comparison of these drilling methods. In some cases the drilling rate of the rotary method is only limited by the time lost in the joining of the drill pipes.

There will be an economic borderline between the field of application of the rotary, jet-bit and that of turbodrilling. This borderline will probably change continually in connection with technical and financial problems. The appearance of turbine competition in the sphere of drilling will result in improved rotary methods. It is too early to define precisely the fields of rotary and turbodrilling. The rotary system has not yet had its final say, and the turbine is still in its infancy.

Controlled Drilling. It is not easy to define exactly the turbines field of operation or the sub-surface engine, so far as normal drilling and financial questions are concerned. If the question is not of drilling better or more cheaply, but of controlled drilling there exists a market for these new methods. This embraces directional drilling. The desire, or necessity, for directional drilling occurs often in modern drilling technique as in fishing operations, blow-outs and outbreaks of fire, when the well may be saved by deflecting the hole; when it is difficult to find a drilling site (in towns or mountains, etc.); when foundation costs are very high, as in offshore drilling, making it necessary to distribute these costs over several boreholes.

For many years drillers have tried to find methods of directing the bit at will below ground. All the special methods and equipment, which are expensive, difficult to handle and unreliable, appear unnatural and antiquated, when compared with directional turbodrilling. A turbine is steered underground as easily as a ship at sea. The field of directional drilling alone, would be large enough to justify the setting up of turbodrilling industry. There is no doubt that as soon as the drilling specialists have become better acquainted with this technique, they will extend the use of controlled drilling. Old dreams of drillers, such as drilling into oil-bearing strata parallel to the dip, will become normal practice in the future.

Bottom-Hole Studies. Recently we reached the stage of investigating what really takes place at the bottom of the borehole. Coordinating the various elements of the flush circulation, the pumps, pumping lines, drill pipes, turbine, bit and annular space, will demand a new skill. There is an art in the rotary technique for selecting the bit which suits the formation, the volume and the pressure of drilling mud. We are just beginning to penetrate the close relationship between the mode of operation of the turbine and the bit, which is dependent upon the formation. We will assume that in a given case the type of turbine, the properties of the drilling mud, the flush rate and the type of bit have been established in the usual way. The remaining problem for the driller is the load he applies to the bit. As in rotary drilling, the load is regulated according to the indication of the drillometer. Any alteration of this load changes the balance between turbine, bit and formation.

If the turbine is lowered to above the bottom of the borehole an initial problem arises at one: "How is it to be started?" If the pumps are set going and the volume of mud circulated rises from 0 to Q_o gallons per minute, the pressure gradient p_o in the turbine rises as the square of Q:

$$\frac{p_o}{p'_o} = \left(\frac{Q_o}{Q'_o}\right)^2$$

and starting torque (T_o) rises in the same proportion:

$$\frac{T_o}{T'_o} = \left(\frac{Q_o}{Q'_o}\right)^2$$

If W_r is the weight of the rotor, the axial reaction of the turbine on the bearing is:

$$G_o = cp_o + W_r$$

"c" being a constant factor. If (f_o) is the coefficient of friction of the thrust bearing at speed 0, the total moment of resistance of the thrust bearing M_r is:

$$M_r = f_o r\,(cp_o + W_r)$$

where (r) stands for the average radius of the thrust bearing, or

$$M_r = f_o r\left[\left(\frac{Q_o}{Q'_o}\right)^2 cp'_o + W_r\right]$$

If (f_o) were constant, the moment of resistance would be represented by a parabola, which would meet the axis of ordinates at point:

$$M_r = f_o \cdot W_r$$

The coefficient of friction is, an empirical function of the specific pressure on the bearing. According to Gusman (b) f_o can lie between 0.33 for a specific pressure of 28 pounds per square inch and 0.13 for 250 psi. In order to illustrate these and the theoretical considerations coming later, take a given turbine already in existence as an example. We have chosen one of the turbines about which the most complete data can be found in generally available publications. All examples given below will apply to the Russian turbine T 14 M 1—9¾-inch, and all the corresponding details are taken from one of the four references given in the bibliography at the end.

The T 14 M1 is a 96-stage axial-flow turbine, with an external diameter of 9⅞ to 10¼ inches with 200-hp output at 640 rpm for a circulation rate of 575 gallons per minute with a specific gravity of 1.2. At this flush rate the turbine has a pressure gradient of 785 psi and a torque of 1626.8 foot-pounds. The total bearing surface of the thrust bearing has been assumed to be 77.5 square inches with

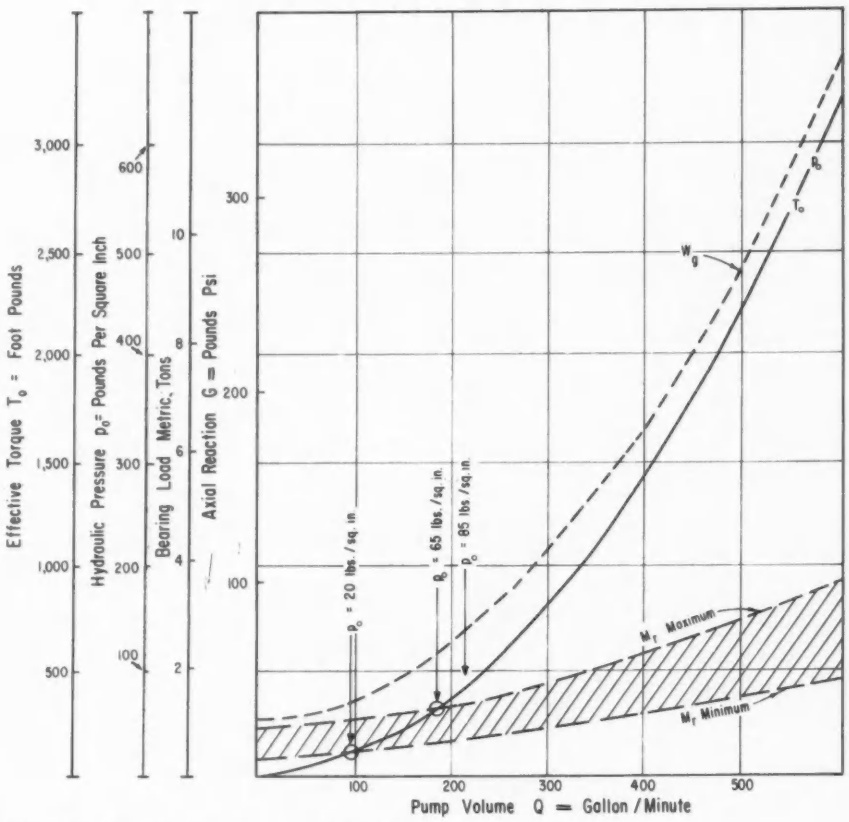

FIGURE 2—Effective torque of turbine is presented as a function of circulation rate. Hydraulic pressure of rotor is presented from which curve Wg is derived. Resistance coefficients for different specific pressures have been derived and the maximum moment of resistance of bearings under starting load is shown.

a mean radius of 2.76 inches. The weight W_r of the rotor has been put at 1 ton. To plot Figure 2 the effective torque of the turbine (T_o) is represented as a function of the circulation rate. A change of scale makes it possible to use the same curve for the hydraulic pressure on the rotor p_o. The curve W_g is derived from this. These resistance coefficients for different specific pressures have been derived and from them, the maximum moment of resistance of the bearings, when starting has been calculated. A minimum moment of resistance-line is indicated underneath, with the assumption that the coefficients of friction are half as large as for the maximum. This is roughly the case with water. The curve indicates the turbine normally starts at a circulation pressure of between 20 and 65 psi.

Instructions for the operation of turbines point out that starting pressures of over 85 psi are regarded as excessive. If the bearings are worn, the coefficient of friction can rise sharply. One method of getting a difficult starting turbine to rotate i to relieve the load on the bearings b applying pressure on the bit. In Fig ure 3 the moments of resistance o the thrust bearings have been drawn and the corresponding specific mo ments of resistance to indicate th total load on the bearings. The thre curves A, B and C represent th moments of resistance of the bit, wit rising load and for specific moment of resistance of 36, 72 and 145 foot pounds. It is evident that for a maxi mum moment of resistance M_r it i useful to relieve the bearings, belov 160 gallons per minute for specifi moment of resistance (M_{sp}) = 14 foot-pounds and below 550 gallon per minute for M_{sp} = 72 foot-pound increasing the weight on the bit be yond this would only result in furthe deceleration of the turbine. The cor responding weights, to be applied t the bit, can be read on the curves o the specific resistance of the bearings Another method for facilitating th starting of the turbine is slow rota tion of the rotary table. The table i rotated counter to the normal rota tion of the rotor. This method can b

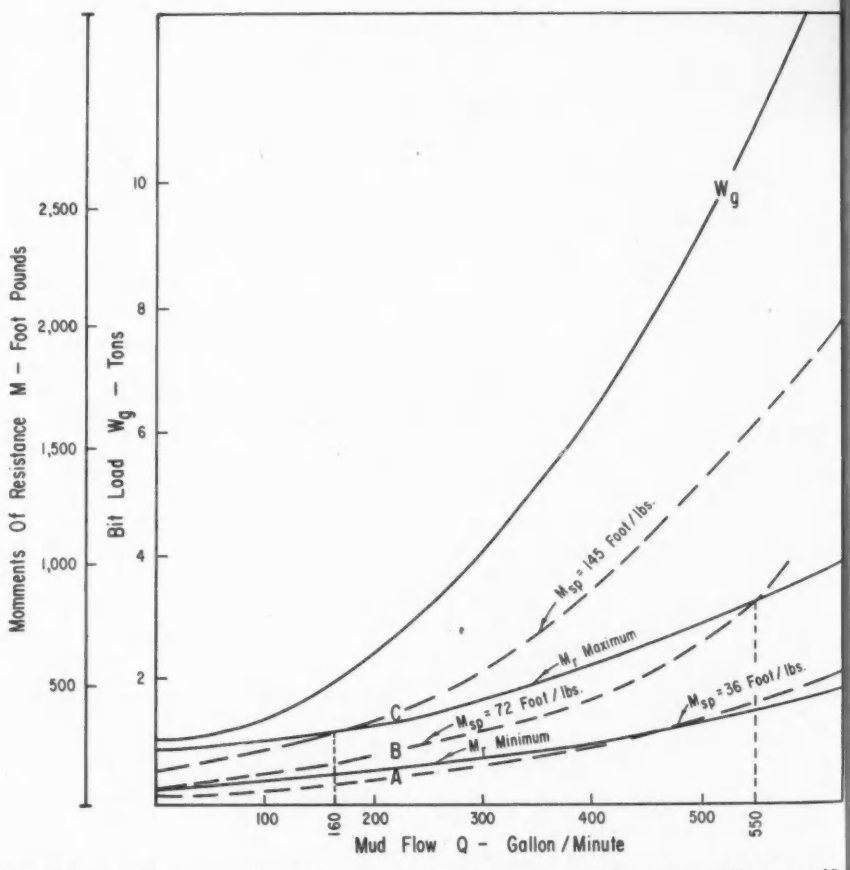

FIGURE 3—Moments of resistance of thrust bearings and corresponding specific moments of resistance indicate total load on bearings. Three curves, A B and C, represent moments of resistance of bit with increasing load and for the specific moments of resistance of 36, 72 and 145 ft. lbs.

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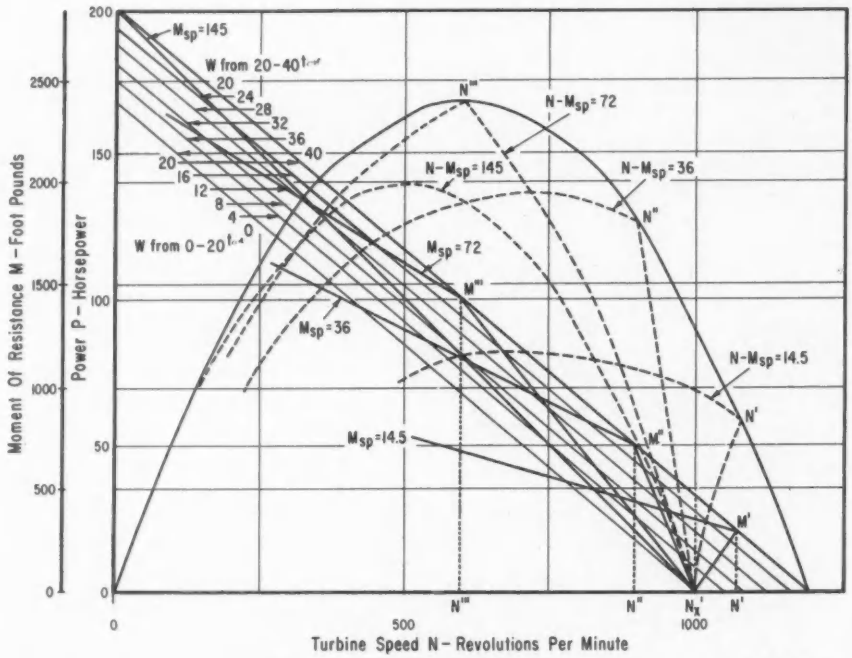

FIGURE 4—Performance and specific moment curves for a hypothetical turbine with a given mud volume, and assumptions as to the moment, and corresponding weight, speed, and also the speed of the suspended turbine. Results of different loads on thrust bearing are shown. Line Marked O represents the useful moment when freely suspended turbine has its full load on the thrust bearings.

useful if the bearings happen to stick. The turbine is now running.

Before going further into the actual example, let us investigate the case of a hypothetical turbine, for which the maximum torque $T_o =$ 2900 foot-pounds and the maximum speed when idling $N_o = 1200$ rpm.

Assuming that the moment of resistance of the bit is proportional to the load on the bit and independent of the rotation speed. This hypothesis can be used with sufficient precision in practice, at the present level of knowledge. If M_{sp} is the specific moment of resistance in foot-pounds per ton of bit load and W is the bit load in tons, the moment of resistance is:

$$M_r = M_{sp}\ W \text{ ft. lbs.}$$

Assuming that the specific moment of resistance of the thrust bearing is independent, of size and pressure and the speed of revolution, or specifically the coefficient of friction (f) is constant. For an average radius (r) in feet, and for a load of (W_g) tons on the bearing, the moment of resistance of the bearing is:

$$M_b = f \cdot r \cdot W_g \text{ ft. lbs.}$$

This assumption is completely false! (f) varies within very broad limits from 0.03 to 0.30 and beyond. This variation occurs as a function of the specific pressure on the bearings, the rate of circulation, and the composition of the drilling fluid. The fluctuations of (f) are so large that no simple law can be applied. For that reason, we shall first investigate the theoretical case, in which (f) is constant.

Assuming the hydraulic pressure on the shaft is independent of the speed of revolution. This is not quite correct, for the pressure gradient in the turbine is not constant. It drops somewhat for the speeds of revolution N_o to N_x.

Figure 4 represents the performance and moment curves of this hypothetical turbine. For a given mud volume it has been assumed that $M_o = 2900$ foot-pounds; $N_o = 1200$ rpm; $W_g = 20$ tons and $N_x = 1000$ rpm. N_x is the speed of revolution of the freely suspended turbine when idling.

Lines parallel to the straight line representing the torques of the turbine have been drawn, each represents the moment of resistance when 4 tons are added to the pressure on a thrust bearing. The line marked 0 represents, the useful moment, when the freely suspended turbine bears the full load on the thrust bearings. These lines represent the useful moment curves of bit loads of 0 to 20 tons, where 20 tons corresponds to the relief of the load on the thrust bearings, and then back again from 20 to 40 tons. It is easy to plot the moment curves of a bit, if the specific moment of resistance "bit/formation" is known. Four cases have been plotted on Figure 3:

1. $M_{sp} =$ 14.5 ft. lbs. extremely hard formation
2. $M_{sp} =$ 36 ft. lbs. hard formation
3. $M_{sp} =$ 72 ft. lbs. moderately hard formation
4. $M_{sp} = 145$ ft. lbs. soft formation

(This classification is only given as an illustration for it depends on the rock, the choice of bit and the bit wear.)

The curve for each formation is composed of two segments of straight lines, intersecting at the maximum moment curve or the bearing relief point. The specific moment of resistance of the bearing of this hypothetical turbine is equal to 24 foot-pounds and this would agree with a coefficient of friction of 0.048. If the specific moment of resistance of the formation is less than the turbine bearing, the turbine is accelerated when weight is placed on the bit. This acceleration is maintained until the bearings are relieved of load. At a formation resistance moment of 145 foot-pounds the bearings for the given turbine can never be relieved. The maximum performance of the turbine can only be used in formations of a given moment of resistance. In too hard or too soft formation the performance falls rapidly. The maximum performance of a given bit and a given formation seldom coincides with the relief point of the turbine.

For $M_{sp} = 36$ foot-pounds the bearings are relieved at 900 rpm, but maximum performance lies at 700 rpm, which corresponds to 20 tons bit load. In the case of formations which are too hard or too soft, the equilibrium for the given turbine can be very unstable when the bearings are relieved. It may be said there should be one turbine for each formation and each bit. The situation can not be improved by altering the rate of circulation of the drilling fluid, for the pressure gradient changes with the torque. The family of curves shifts to the right or left if Q increases or decreases. The driller must adopt a turbine speed suitable for the bit as well as fulfill the other conditions. This illustration shows how complicated turbodrilling can be.

THE END OF PART I

WIRE ROPE AT WORK

Crews of the Rutledge Drilling Company make hole fast. Here's a typically busy Rutledge outfit, snapped by the photographer in northwest North Dakota. The men were letting no grass grow under their feet, as the log-book proved. In three days' time, they had sunk the hole to 5000 ft through tricky sand and shale. They expected to go an additional 3600 before completing the well.

On their previous job they had gone to 8417 ft in record time for that particular field. In the drilling of both wells, Bethlehem rotary line was used—the same sturdy rope you see in the picture. Rutledge rigs are equipped regularly with Bethlehem wire rope, for this tough, long-lasting product is always dependable, always a top-flight performer.

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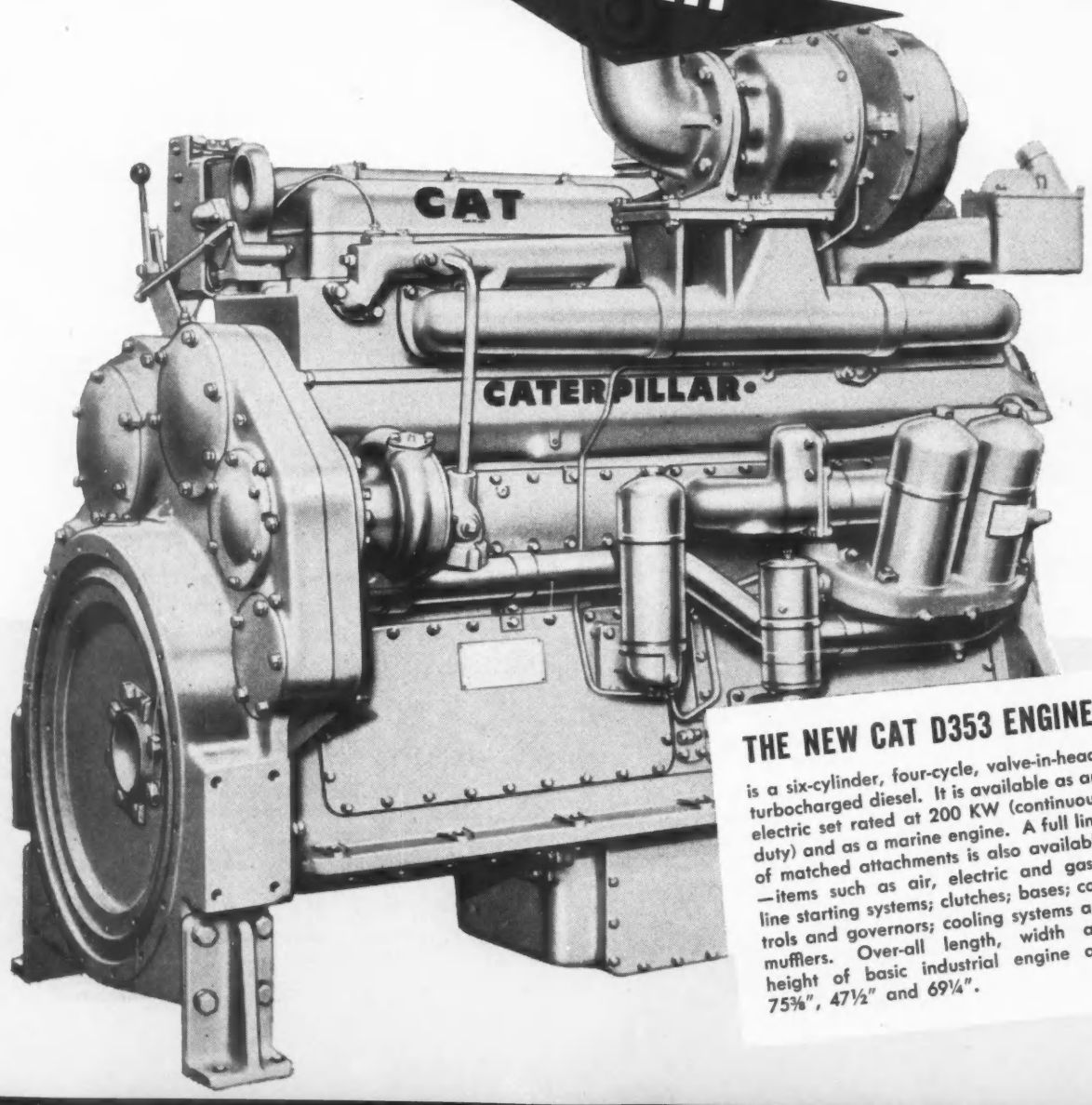

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is a six-cylinder, four-cycle, valve-in-head turbocharged diesel. It is available as an electric set rated at 200 KW (continuous duty) and as a marine engine. A full line of matched attachments is also available —items such as air, electric and gasoline starting systems; clutches; bases; controls and governors; cooling systems and mufflers. Over-all length, width and height of basic industrial engine are: 75⅜", 47½" and 69¼".

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D337	D326	D318 (SERIES G)	D315 (SERIES G)	D318	D315	D311
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†Maximum output capacity

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For complete information about the new D353 and other Cat Diesels, see your Caterpillar Dealer. Let him show you how diesel leadership based on a quarter century of experience can engineer the modern, heavy-duty diesels of tomorrow.

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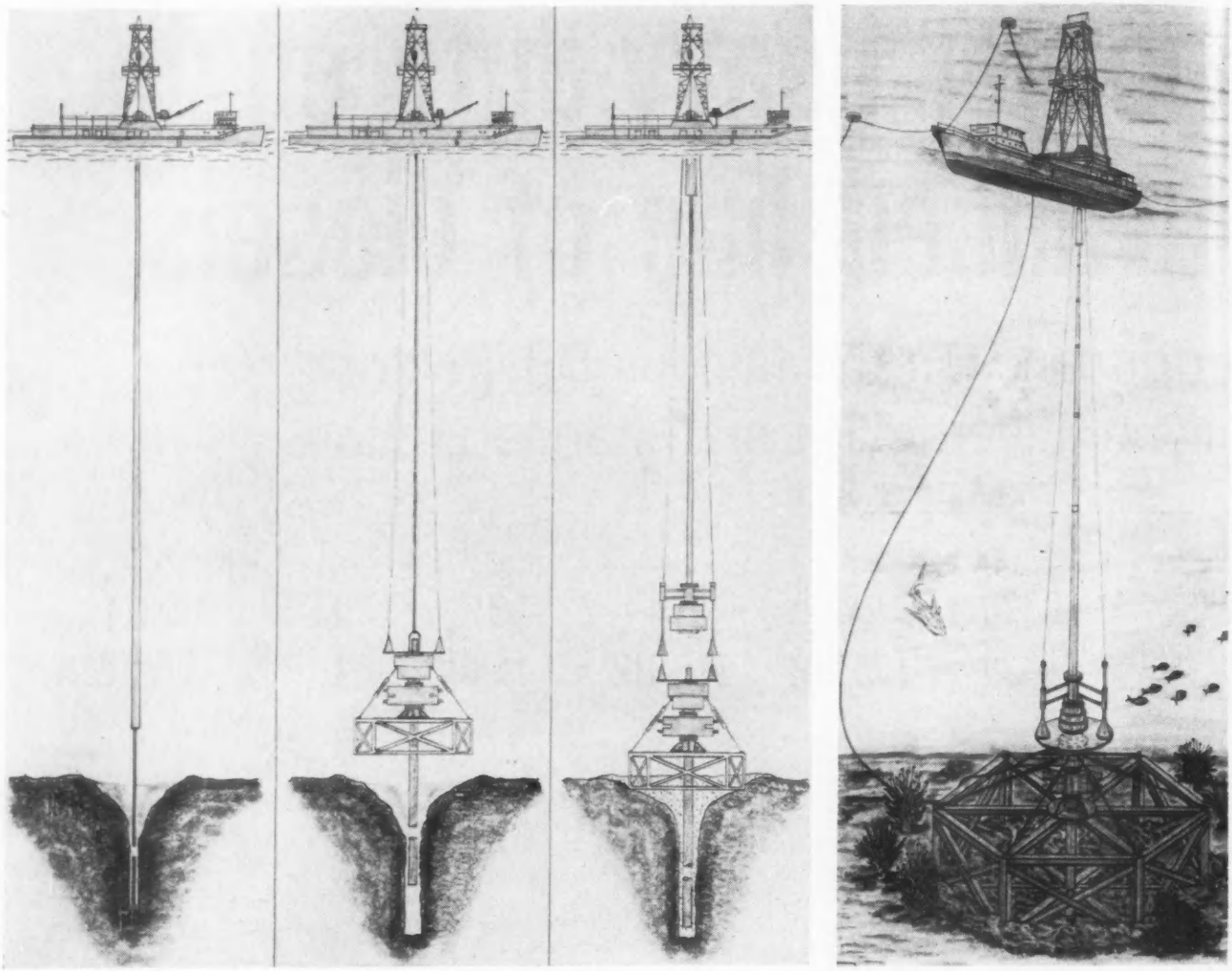


Here's how the CUSS group drills in water depths of 1000 feet or more. Three-panel drawing above shows surface casing (left) hanging from barge with bit on pipe drilling original hole on ocean bottom, using salt water as a circulating medium. Center drawing shows lowering into place of surface casing which has a flanged casinghead and two conventional blowout preventers. On top of the assembly guides are two guide cones and guide cables extending to the barge. These guide cables will later be used for re-entry into the hole of drilling bits and other tools. Third panel shows surface pipe and wellhead equipment cemented into place in conventional manner, and packoff assembly being lowered into place over guide cones preparatory to running the drill bit and drilling ahead. Extreme right is artist's conception of wellhead and anchoring system plus stabilizing jacket on ocean floor.

Offshore Drilling Goes Deeper

New technique developed by the CUSS group to drill in water up to 1000 feet or more. Opening of vast new areas promised.

A NEW procedure for drilling oil wells offshore in water depths up to 1000 feet or more with virtually the same ease and cost as drilling on land has been developed and patented by Continental Oil Company, Union Oil Company, Shell Oil Company, and The Superior Oil Company.

The system has world-wide application in opening up vast new underwater areas for developing oil and other mineral resources beneath the ocean's surface.

The CUSS Group, with Union Oil as operator, has already used the patented techniques successfully to drill over 300,000 feet of hole, in water depths believed impossible to explore. Holes have been drilled in water depths up to 1500 feet even though the comparatively small vessel containing the equipment rose, fell and swung about under the impact of waves and ocean currents. In

recent months an average of 450 feet a day have been drilled under such conditions.

The system involves forming a base of operations at the bottom of the ocean connected to the ship on the surface by flexible guide cables. A drilling bit is suspended from the vessel by a number of lengths of drill pipe, and is guided by the cables to drill at the desired point. The pipe string extending from the vessel is sufficiently flexible to permit lateral motion of the boat. Guide cables are used to communicate with the hole for purposes of re-entry and to change bits.

An interesting feature of the system is the provision of an apparatus on the bottom of the ocean to permit continued circulation of drilling mud. In effect, this invention makes possible ocean bottom drilling in the same manner and with almost the same ease as dry land drilling.

Principal points of the patented system are:

- It is a conventional heavy drilling rig unitized and rigged up in a "seagoing package," allowing immediate drilling with no rig-up time;

- There is no definable limit to water depth for drilling operations;

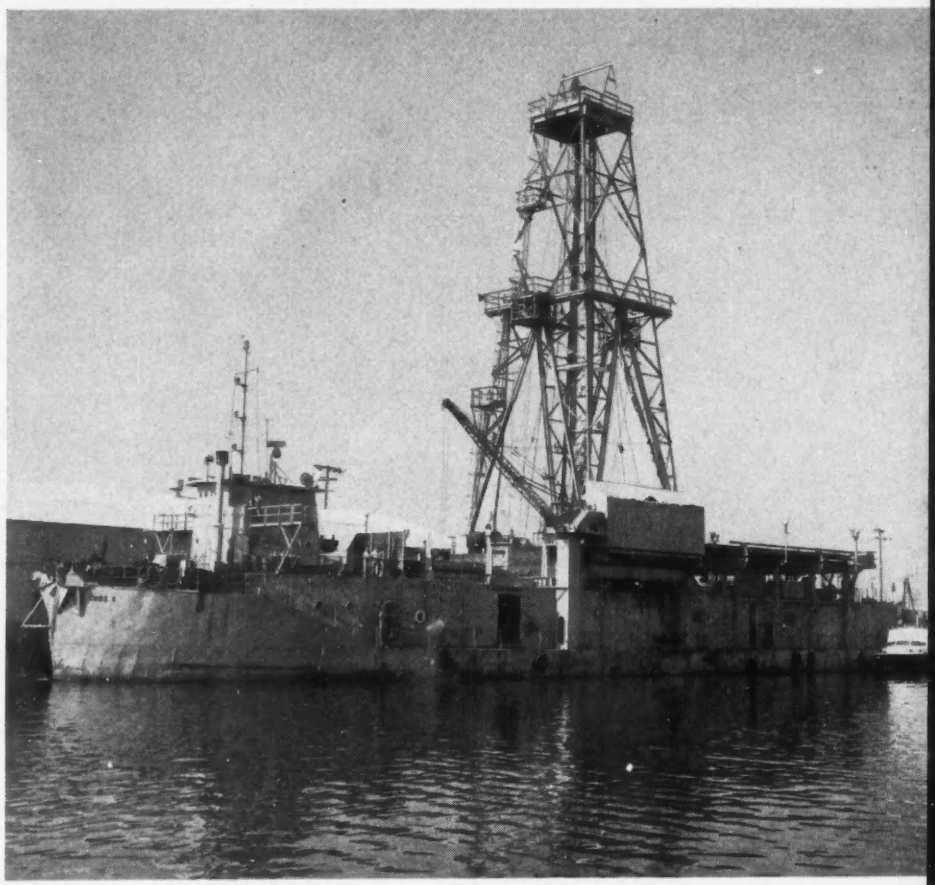
- It represents an immense saving in offshore exploratory drilling as there is no expensive platform construction and removal cost;

- Conventional blowout prevention equipment and well testing procedures may be used.

"The new technique enables drilling operations to be carried on in water far deeper than ever thought possible even a year ago."

In 1953 the four companies, started an exploratory drilling program off the coast of California. The technique of drilling from a floating vessel, embodying the features of hole re-entry, mud circulation, and the use of blowout preventers was successfully used in early 1954. As a result, a large new drilling barge was commissioned in 1956. Basic patents and a number of pending applications cover the entire process.

—The End



Revolutionary "seagoing oil drilling rig" is the CUSS I which enables oil seekers to drill in water depths of 1000 feet or more with virtually the same ease and cost as drilling on land, and open up vast new underwater areas for exploration. Patents on the technique have been issued to the CUSS group consisting of the Continental, Union, Shell and Superior oil companies. CUSS I, a fully unitized drilling barge, is a converted YFNB freight barge of 1479 gross tons. Dimensions are: Length, 260 feet; beam, 48 feet; derrick, 95 feet high, weight, 500,000 pounds; engines, four 600 hp diesels; Anchors, six 7500 pound lightweight with 1½-inch chain; draft, light, 5 feet 10 inches, loaded 10 feet 5 inches.

Main deck level of CUSS I showing center well (covered with grating), the base assembly (center) with projecting cones which slip over those of the base assembly to lock the units together at bottom of ocean.

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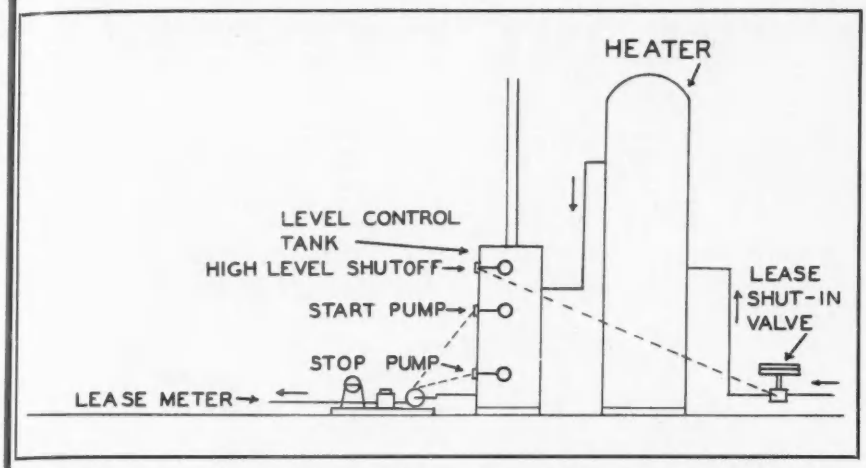
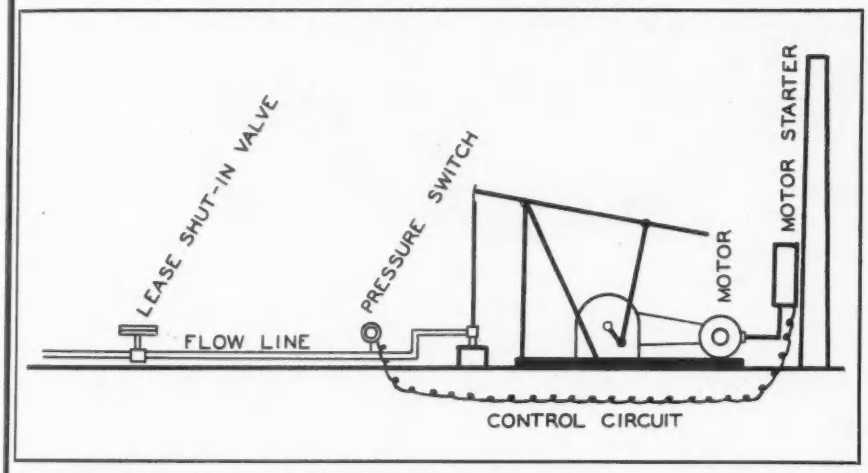


FIGURE 1—From the heater treater, oil flows into a 20-barrel sump tank then to the lease meter unit. From the lease meter unit, the oil is pumped to a central LACT where it is transferred to the pipe line.



When the automatic shutdown valve opens, pressure is released at well pressure switch and pumping unit motors start automatically.

'Fail-Safe' LACT Unit; Here's How It Works

Positive displacement meters are used to meter oil from various leases and transfer it to a pipe line through central lease automatic custody transfer unit.

By Frank W. Beach
Cities Service Oil Company, Bartlesville

THE NECESSITY for tank battery replacement on adjacent leases brought about the suggestions that oil be metered from each lease and commingled at a central tank battery. Later it was proposed to meter the oil from each lease to a central lease automatic custody transfer unit. To carry out this operation of automation all necessary steps were taken and permission for a six-months' trial period was received from the Railroad Commission in April, 1957.

There are two methods of measuring crude oil. One is the weir or "seraphin" neck type measuring tank, the other is the positive displacement meter.

Both systems have proved to be accurate and dependable. For this initial installation, it was decided that P.D. meters would be used for the following reasons:

1. Many pipe line departments have used P.D. meters with satisfactory results.
2. P.D. meters supposedly have advantages over tank type meters.
   a. P.D. meters are smaller, lighter, and more adaptable to skid mounted units.
   b. Automatic temperature correction is not available on many tank type meters.
   c. P.D. meters are better adapted to continuous flow.
   d. P.D. meters are not as subject to deposition and corrosion as tank type meters.
   e. Accuracy of P.D. meters is not dependent on floats and valves.
3. There is a tank type LACT Unit in operation near this installation and operating under the same conditions. Valuable comparisons can be made in the relative merits of the two different systems.

Lease Metering System. The lease automatic meter system is designed for unattended and fail safe operation.

Oil wells on the leases are pumped with electric motors. Fluid from the oil wells is pumped through lead lines to a lease header. At the header, the oil is routed to a heater treater. From the heater treater, oil flows into a 20-barrel sump tank, then to the lease meter unit (Figure 1). From the lease meter unit the oil is pumped to a central LACT where the oil is transferred to the pipe line.

Individual Well Control. At times it is necessary to interrupt the operation of the oil wells due to production of the lease allowable or to malfunction of a lease meter unit or the LACT Unit. Any of these situations will cause an automatic valve on the line between the header and the heater

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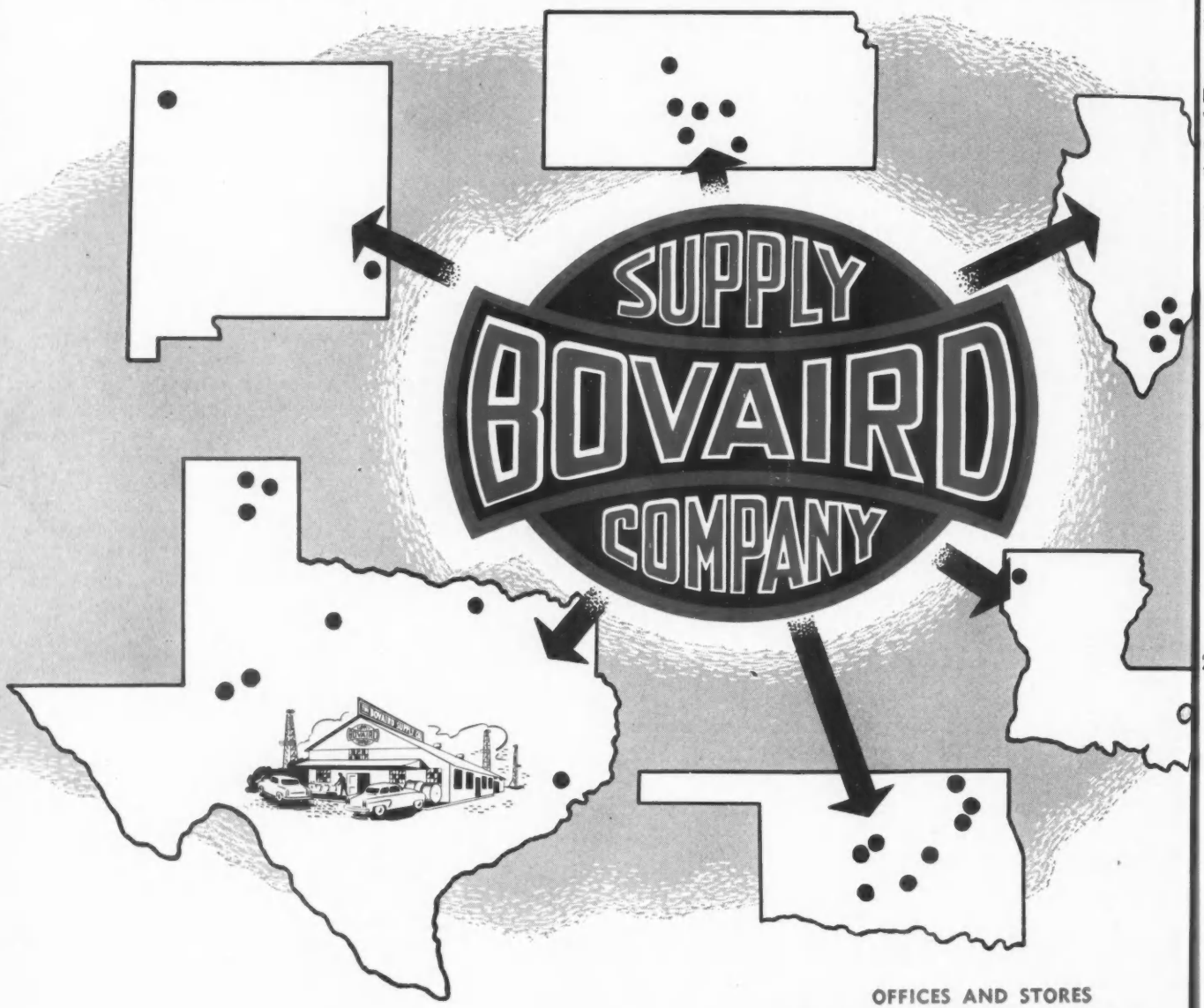

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treater to close allowing the wells to pump against a closed valve. The increase in lead line pressure operates a pressure switch near the well which shuts down the pumping motor. When the automatic shut down valve opens, the pressure is released at the well pressure switch and the pumping unit motors automatically start (Figure 1-A).

Design of Lease Metering Units. Three skid mounted lease metering units are used. Each meter system has the following components:

1. **Surge and Level Control Tank (Figure 1)**

The surge tank is 4 x 10, 20-barrel tank located on the discharge side of the heater treater. Oil from the heater treater enters the surge tank. Free gas is vented from the top of the surge tank. Oil entering the surge tank activates a float control which starts an electric driven rotary oil pump on the meter skid. A low level float control stops the motor driven pump when oil level drops due to lack of flow into the surge tank. A high level float activates a lease shut-in valve ahead of the heater treater.

2. **Skid Mounted Meter Unit**

The lease meter unit is designed so that all fabrication and testing can be done in a shop to eliminate expensive field fabrication and alterations (Figure 2).

The components are mounted on the skid 33 inches wide by 80 inches long so that any component can be easily serviced or removed without disturbing other components. Height of the complete assembly is 34 inches. The floor of the skid is fabricated of expanded metal for good footing and easy maintenance. Mounted on the skid are the following components in order of flow through the unit.

a. Oil Pump

Oil from the surge tank flows to the inlet of a rotary pump. The pump has a built-in pressure relief valve for relief of excessive pressure. Normal operating pressure is from 5-40 pounds. The pump is operated by a 2 hp explosion proof motor.

b. Strainer

From the pump oil flows through a strainer to remove foreign materials.

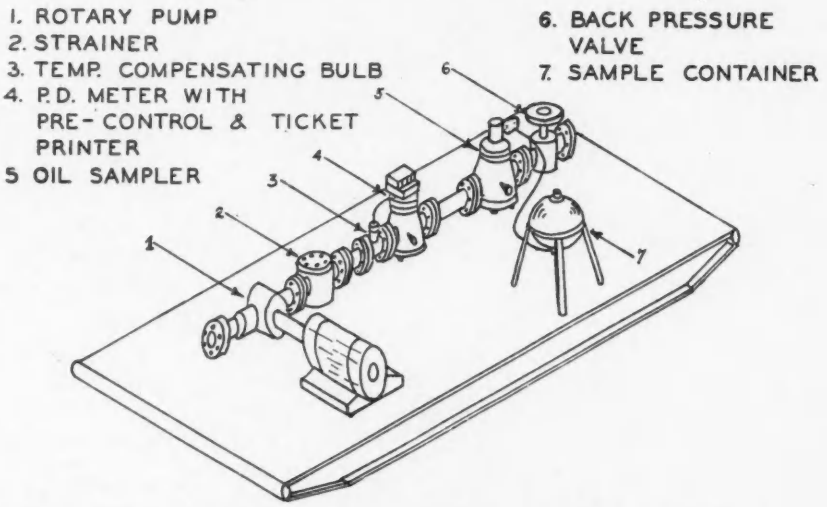


FIGURE 2—Lease meter unit is designed so that all fabrication and testing can be done in a shop to eliminate expensive field fabrication and alterations.

c. Positive Displacement Meter

Oil flows through the meter at a pressure of from 5-40 pounds at a rate of 20 gallons per minute. With a uniform pressure and flow rate the P.D. meter is operating under conditions favorable to accurate measurement.

Meter size = 1½ inches
Maximum capacity = 60 gpm or 2064 bbls./day
Pressure rating = 150 pounds
Case = Cast iron
Temperature compensated = Reads net barrels at 60° F.
Pre-control = Shut off flow when allowable is run
NC Counter = Reads net barrels to nearest $\frac{1}{10}$ barrels.

d. Sampler

From the P.D. meter, oil passes through another meter which drives the oil sampler at a rate proportional to the flow of oil. An oil sample is saved in a 1 gallon vapor tight container for BS and water determination.

e. Back Pressure Valve

A back pressure valve maintains a 5-40 pound back pressure on the meter unit to provide a uniform metering environment and to reduce the possibility of the release of gas from the oil. From the meter units the oil flows to the central LACT Unit.

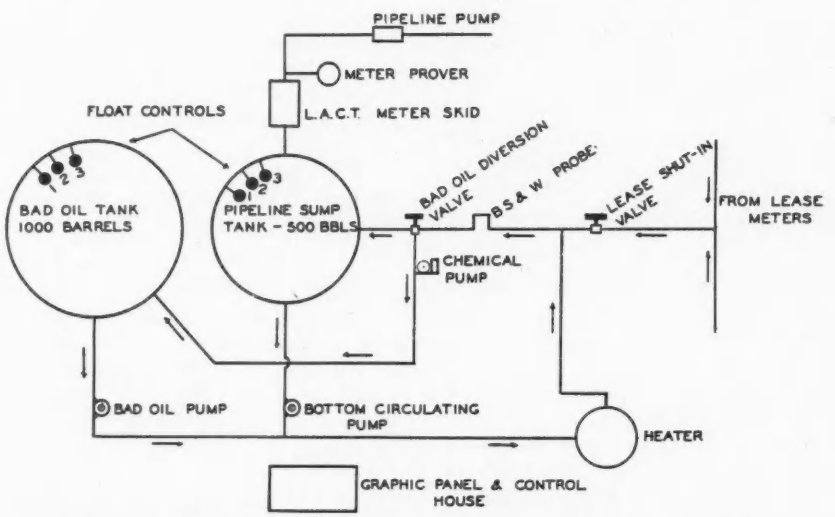


FIGURE 3—Schematic diagram of flow in LACT unit. The various components are listed and shown in respective places.

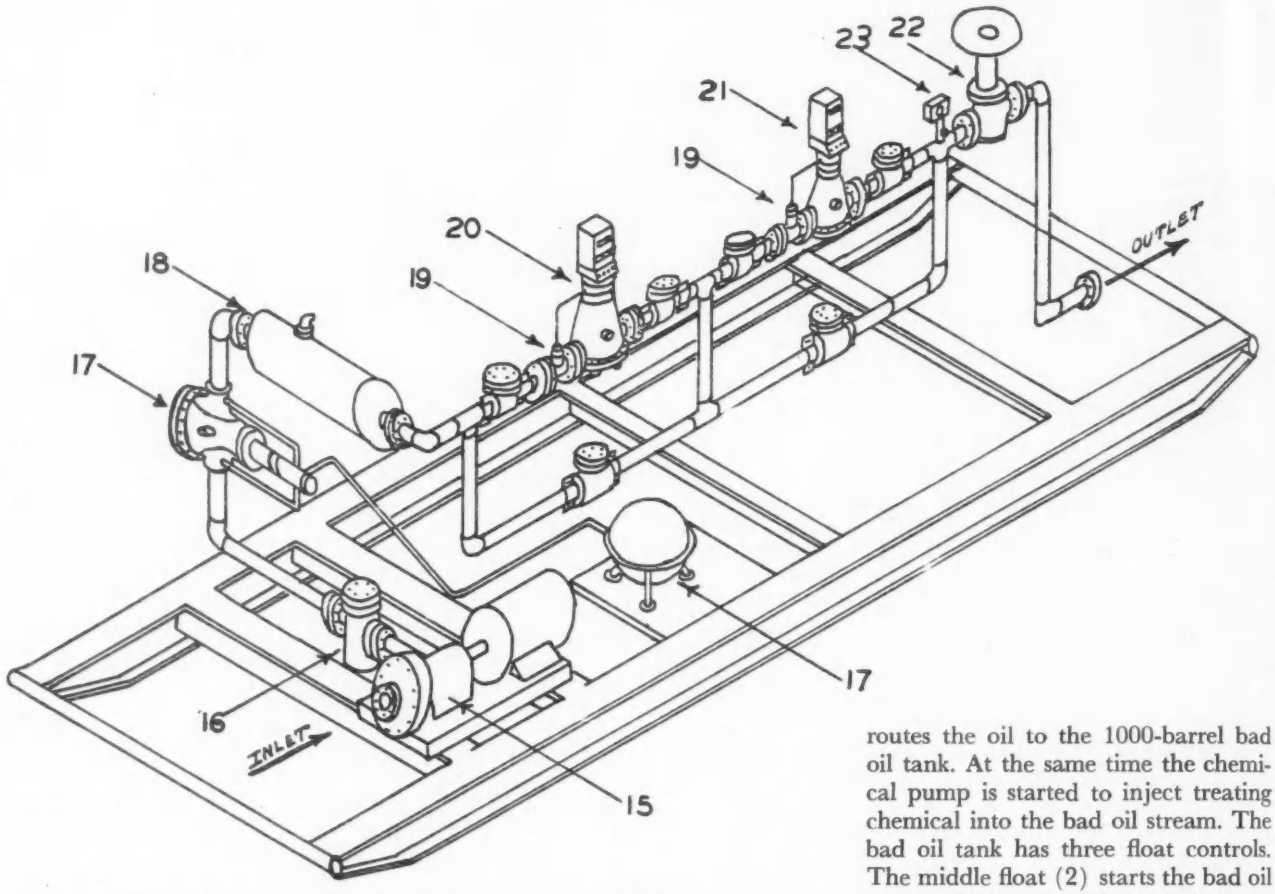


FIGURE 4—This skid-mounted LACT meter unit shows centrifugal pump (15), strainer (16), automatic sampler (17), air release (18), sales meter (20), check meter (21), temperature compensator (19), back-pressure valve (22), and pressure switch (23).

Functions of LACT Unit. The functions of the LACT unit are to receive oil from various lease meters, monitor the oil for merchantable quality, and meter the oil to the pipe line under conditions that insure accurate measurement of oil volume corrected for temperature, gravity and BS&W. The LACT unit automatically diverts bad oil through a heater treater system until the oil is acceptable for the pipe line. All operations are designed to be fail-safe for unattended operation.

LACT Unit Components. The LACT unit has the following components listed in order of flow through the unit (Figure 3).

1. The lease meters flow into a single line leading to the LACT unit
2. 3-inch lease shut-in valve
3. BS&W monitor
4. 4-inch bad oil diversion valve
   A. Chemical pump-gas operated
   B. 1000-barrel bad oil tank
   C. Bad oil circulating pump
   D. Heater treater
5. 500-barrel pipe line sump tank
   A. Bottom circulating pump
6. Skid mounted LACT meter unit (Figure 4)
   A. Centrifugal pump (15)
   B. Strainer (16)
   C. Automatic sampler (17)
   D. Air release (18)
   E. Sales meter (20)
   F. Check meter (21)
   G. Temperature compensator (19)
   H. Pre-Control (24)
   I. Back pressure valve (22)
   J. Pressure switch (23)
7. Flow line to pipe line pump
   A. Meter prover
8. pipe line pump

Operation of the LACT Unit. The operation of the LACT unit will be described by following the flow of oil through the unit.

Oil flows to the LACT unit through a 4-inch plastic lined pipe and through a 3-inch lease shut-in valve. Oil flows through the BS&W probe mounted in a riser in the 4-inch line. If the oil is of merchantable quality, oil flow is directly to the pipe line sump tank through the 4-inch bad-oil diversion valve. If the oil contains an excess of BS&W, the bad oil diversion valve routes the oil to the 1000-barrel bad oil tank. At the same time the chemical pump is started to inject treating chemical into the bad oil stream. The bad oil tank has three float controls. The middle float (2) starts the bad oil pump which pumps the bad oil to the heater treater and then back through the BS&W probe. If the oil is then of merchantable quality the oil is routed to the pipe line sump tank. The lower float control (3) in the bad oil tank stops the bad oil pump. The top float control (1) activates the lease shut-in valve which stops the flow of oil into the LACT unit.

The pipe line sump tank also has three float switches. Oil fills the sump tank until the middle float (2) is reached. This float (2) activates the motor starter on the meter unit skid. At the same time the bottom circulating pump is started. The centrifugal pump on the meter skid builds up a pressure of 30 pounds which operates a pressure switch connected to the pipe line pump motor. A timer on the pipe line pump allows the pipe line pump motor to start only at times acceptable for pipe line delivery. Oil is run to pipe line until the bottom float switch is reached. At that time the meter unit motor is stopped which also stops the pipe line pump and the bottom circulating pump. If the pipe line sump tank fills up to the level of the top float (3) the bad oil diversion valve is activated to divert the flow of oil to the bad oil tank for storage.

In time the bad oil tank fills up and the top float switch (3) will close the lease shut-in valve and stop the lease production.

The LACT meter unit is skid mounted (Figure 4). Oil from the pipe line sump tank flows to the meter unit. The float switch on the sump tank starts the motor on the centrifugal pump (15). Oil then flows through a strainer (16) then through the automatic sampler (17). From the sampler the oil passes through a P.D. sales meter (20) then the check meter (21). A back pressure valve (22) remains closed until pressure reaches 20 pounds. At the same time a pressure switch (23) starts the pipe line pump. The oil then passes to the pipe line pump.

Graphic Panel. A graphic panel is used with this LACT unit to facilitate operations and detect the point of possible malfunctions of components.

The graphic panel has the layout of the unit inscribed on a metal plate. Colored lights indicate the operation of the more vital components of the system. Green lights indicate normal operation, red lights indicate an abnormal condition.

Control House. The control house contains the control panel, the LACT meter ticket printers, starters for the bad oil pump and bottom circulating pumps and lighting controls.

1. **Control Panel:** The control panel contains:
   a. The graphic panel with lights and controls
   b. The BS&W monitor which is connected to the probe by a coaxial cable.
   c. Miniature strip charts for recording the running time of the P.D. meters.
2. **Ticket Printers:** The LACT meters are mounted on the skid at the battery. Each meter has a reset barrel counter and an accumulative dial. Each meter also has a self-synchronous drive to remotely drive a ticket printer in the control house.

In the control house a meter head is mounted on a stand. The meter head contains a self-synchronous motor driven by the meter on the skid. The self-synchronous motor drives a ticket printer and pre-control. When the allowable is run, a microswitch breaks the electrical circuit to the motor on the meter unit skid.

Although there are two meters on the skid there is only one ticket printer. Either meter can drive the ticket printer. A sealed selector switch determines the meter used for sales and the meter used for a check meter.

Special Features of LACT Unit

1. **Lease Shut-in Valve:** This valve is powered by gas pressure and is controlled by an electric solenoid pilot valve. The valve is normally closed so that in cases of gas failure or power failure the valve will revert to the closed position and shut in the lease.
2. **Bad Oil Diversion Valve:** The bad oil diversion valve is a gas operated solenoid controlled valve. The valve is installed so that flow is normally to the bad oil tank. In case of local gas supply failure or power failure the valve diverts the oil flow to the bad oil tank. This prevents unmerchantable oil from reaching the pipe line sump tank.
3. **BS&W Monitor:** The BS&W monitor is a capacitance device that is capable of detecting small amounts of water in oil. The device is in two parts, the probe and the control box. In this installation the control box is mounted in the control house and is connected to the probe by a coaxial cable.

   The monitor circuit is so arranged that electrical malfunction or tube burnout in the control itself activates the bad oil diversion valve and diverts the oil flow to the bad oil tank.
4. **Bad Oil Tank and Pipe Line Sump Tank:** Both of these tanks have coned bottom with small pumps taking suction from the bottom of the cone. By this method of operation there is never a chance for sludge to build up in the bottoms of the tanks.

Chemical Pump: The chemical pump is used to inject chemicals into the oil stream when the bad oil valve diverts the flow to the bad oil tank. The chemical pump is driven by gas and is controlled by the bad oil valve.

Float Controls: The float controls are ball floats which operate a micro switch through a torque tube. Movement of the float is very small. The floats are plastic coated to reduce paraffin deposition. The microswitches are mounted in explosion proof housing with readily available adjustment from the outside of the tank.

Cost of LACT Unit: Following are costs of the major components of the LACT Unit and the skid mounted LACT meter unit:

MAJOR COMPONENTS

1—1000 barrel cone bottom tank	$ 3,100
1—500 barrel cone bottom tank	2,100
1—3″ Lease shut in valve	250
1—BS&W monitor	720
1—Bad oil pump—800 bbl./day	400
1—Bottom circulating pump	150
1—Chemical pump—gas operated	150
1—Bad oil diversion valve	262
6—Float control switches @ $.70	420
1—LACT meter unit/skid-installed	5,342
1—Meter proven tank—plastic coated/skids	860
1—10 x 12 building	650
1—Graphic control panel complete	1,150
200′—42″ Plastic lined pipe	250
300′—2″ Plastic lined pipe	210
Total Cost of Components	$16,014

COST OF LACT METER UNIT SKID MAJOR COMPONENTS AND LABOR

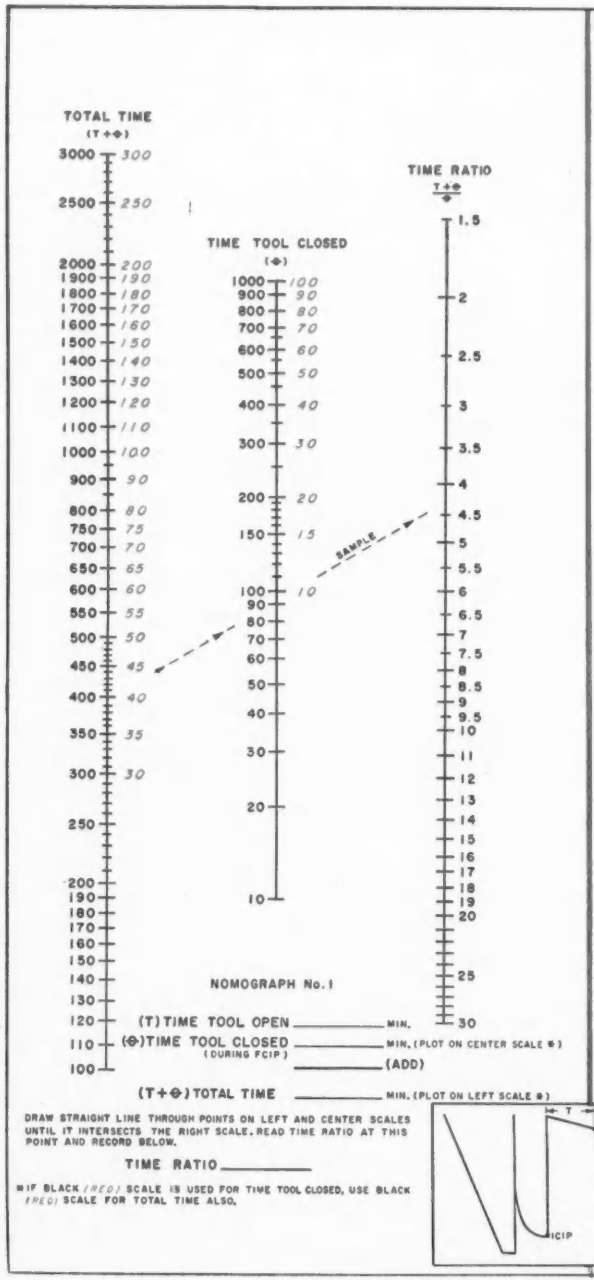
1—1½ hp Centrifugal pump 60 bph @ 30 #	$ 364
1—3″ Cast iron strainer	70
1—3″ Air eliminator	186
2—1½ P.D. meters @ $200	400
2—Barrel adapter plates for above @ $31	62
2—Temperature compensators @ $226	452
2—Remote meter drives (Selson Generators) @ $134	268
2—Barrel Counters @ $65	130
1—Desk stand with ticket printer	307
1—Pre-Control	88
1—Micro switch—Mounted	75
1—Back Pressure Valve	250
1—Explosion Proof Starter	180
1—Explosion proof pressure switch to start pipe line pump	130
21—3″ Victaulic couplings	48
7—Butterfly valves	213
1—Skid and mounting of equipment	980
1—Oil sampler and container	557
1—Engineering and handling cost	475
1—Freight cost	107
Total Cost Complete	$5,342

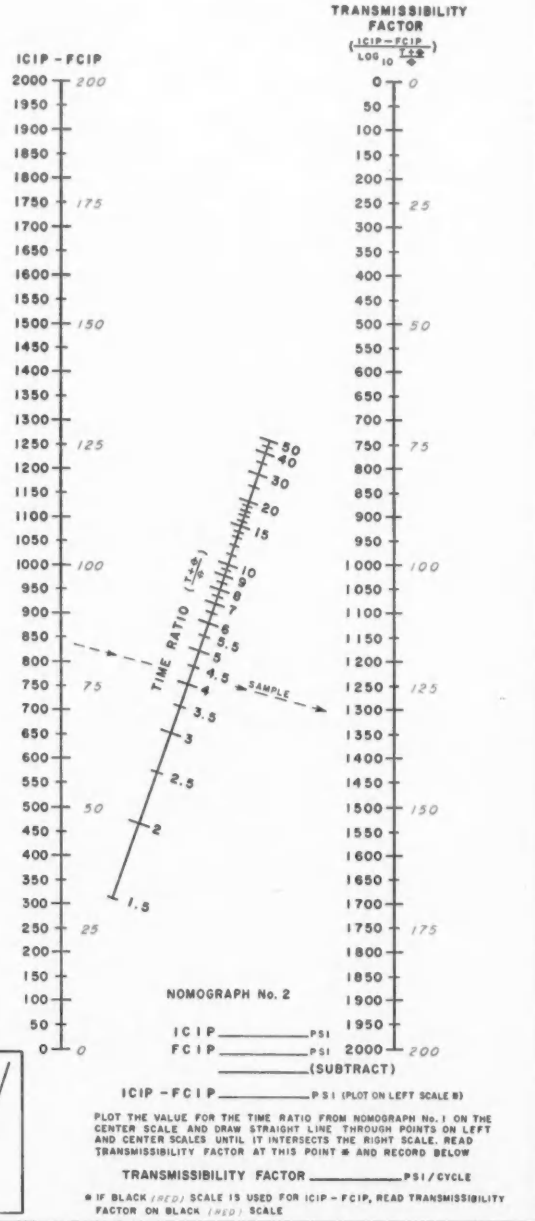
Conclusion. The lease meter units and the LACT unit were designed to provide a meter system which could be skid mounted and shop tested for convenient field installation. The ultimate aim for future automatic lease installation will be to go even further toward package units that can be set in place and put in operation in a minimum time and with a minimum of installation expense.

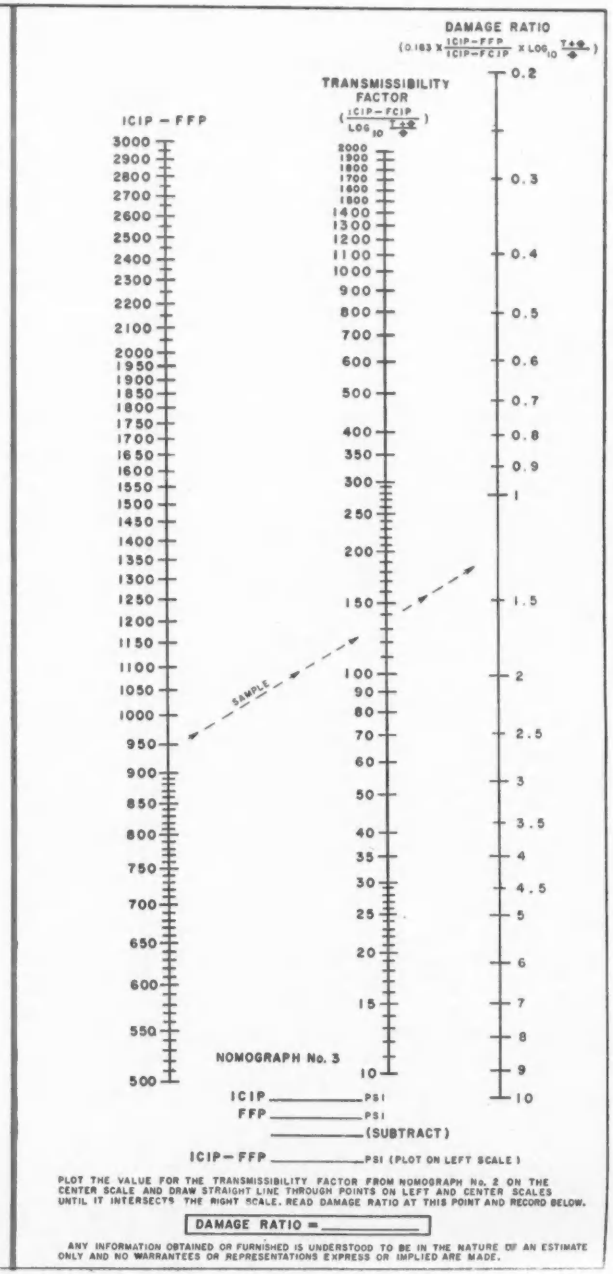
This particular installation could have been improved by mounting the bad oil valve, the BS&W probe, the chemical pump and the lease shut-in valve on a single skid for more convenient field installation.

ACKNOWLEDGMENT

Presented at the Petroleum Industry Conference of the American Institute of Electrical Engineers, Philadelphia, Sept. 11, 1957.


TOTAL TIME
(T+◈)
TIME TOOL CLOSED
(◈)
TIME RATIO
T+◈
◈
SAMPLE
NOMOGRAPH No. 1
(T) TIME TOOL OPEN _____ MIN.
(◈) TIME TOOL CLOSED _____ MIN. (PLOT ON CENTER SCALE *)
(DURING FCIP)
(ADD)
(T+◈) TOTAL TIME _____ MIN. (PLOT ON LEFT SCALE *)
DRAW STRAIGHT LINE THROUGH POINTS ON LEFT AND CENTER SCALES UNTIL IT INTERSECTS THE RIGHT SCALE. READ TIME RATIO AT THIS POINT AND RECORD BELOW.
TIME RATIO _____
* IF BLACK (RED) SCALE IS USED FOR TIME TOOL CLOSED, USE BLACK (RED) SCALE FOR TOTAL TIME ALSO.
T
◈
FFP
ICIP
FCIP


ICIP - FCIP
TRANSMISSIBILITY FACTOR
(ICIP−FCIP / Log10 T+◈/◈)
TIME RATIO (T+◈/◈)
SAMPLE
NOMOGRAPH No. 2
ICIP _____ PSI
FCIP _____ PSI
(SUBTRACT)
ICIP − FCIP _____ PSI (PLOT ON LEFT SCALE *)
PLOT THE VALUE FOR THE TIME RATIO FROM NOMOGRAPH No. 1 ON THE CENTER SCALE AND DRAW STRAIGHT LINE THROUGH POINTS ON LEFT AND CENTER SCALES UNTIL IT INTERSECTS THE RIGHT SCALE. READ TRANSMISSIBILITY FACTOR AT THIS POINT * AND RECORD BELOW
TRANSMISSIBILITY FACTOR _____ PSI/CYCLE
* IF BLACK (RED) SCALE IS USED FOR ICIP − FCIP, READ TRANSMISSIBILITY FACTOR ON BLACK (RED) SCALE


DAMAGE RATIO
(0.183 × ICIP−FFP / ICIP−FCIP × Log10 T+◈/◈)
ICIP − FFP
TRANSMISSIBILITY FACTOR
(ICIP−FCIP / Log10 T+◈/◈)
SAMPLE
NOMOGRAPH No. 3
ICIP _____ PSI
FFP _____ PSI
(SUBTRACT)
ICIP − FFP _____ PSI (PLOT ON LEFT SCALE)
PLOT THE VALUE FOR THE TRANSMISSIBILITY FACTOR FROM NOMOGRAPH No. 2 ON THE CENTER SCALE AND DRAW STRAIGHT LINE THROUGH POINTS ON LEFT AND CENTER SCALES UNTIL IT INTERSECTS THE RIGHT SCALE. READ DAMAGE RATIO AT THIS POINT AND RECORD BELOW.
DAMAGE RATIO = _____
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* IF BLACK (RED) SCALE IS USED FOR ICIP – FCIP, READ TRANSMISSIBILITY FACTOR ON BLACK (RED) SCALE

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Damage Ratio Determined by Drillstem Test Data

Use nomographs to determine the damage ratio of the zone surrounding a well bore.

By H. K. van Poollen
Halliburton Oil Well Cementing Company
Duncan, Okla.

SEVERAL AUTHORS have presented methods to calculate well bore damage from well production and pressure data.[1,2,3,4] This well bore damage actually consists of a zone of reduced permeability immediately surrounding the well bore. The reduced permeability will in turn reduce the productivity of the well.

A reduction in permeability may be due to:

- The effect of drilling fluids on the formation.
- The effect of mud particles on the formation.
- The effect of formation gas released from the formation fluid.
- The effect of physical distortion of the formation by drilling tools.

In certain instances, the permeability immediately surrounding the well bore is higher than the permeability at greater distances. Such may be the result of small fractures induced by drilling operations.

The amount of damage will be expressed as the damage ratio defined as the ratio between the theoretical and the actual productivity index of the well at the time of measurement. For example, if the damage ratio of a well is four, the well might be able to produce four times as much fluid after the damage or the skin surrounding the well bore has been removed. However, if the damage ratio is one or less, the well most likely will not be able to produce any more than was measured originally unless a major stimulation technique is applied.

A knowledge of the damage ratio can be of great benefit at time of the drillstem test. Suppose that only a slightly oil-cut mud is produced during the drillstem test and suppose that the damage ratio is high. The high damage ratio is an indication that the formation may be able to produce more. The production of mud indicates that drilling fluid was lost to the formation. This fluid loss might be the reason for a high damage ratio. In that case, either re-testing for a longer period or re-testing after damage has been removed may reveal the true formation fluid.

On the contrary, if clean oil in non-commercial quantities is produced in conjunction with a low damage ratio, the chances of converting the tested zone to a commercial producer are small unless a major stimulation technique is used.

Fairly precise methods have been described in literature to calculate the damage ratio. These methods are somewhat cumbersome for well site use. Therefore, an approximation has been suggested whenever a dual closed-in pressure is available. The major requirement is that the initial closed-in pressure approaches the static reservoir pressure. This pressure is then assumed to be the reservoir pressure.

The basic data necessary to calculate the damage ratio are: (T) time the tool is open to flow, (Θ) time the tool is closed during the final closed-in period, (ICIP) the initial closed-in pressure, (FCIP) the final closed-in pressure, and (FFP) the final flow pressure.

The damage ratio may then be calculated by the formula:

$$\text{DAMAGE RATIO} = 0.183 \times \frac{\text{ICIP} - \text{FFP}}{\text{ICIP} - \text{FCIP}} \times \log_{10} \frac{T + \Theta}{\Theta}$$

For rapid field use the nomographs herewith can be used.

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[1] A. F. Van Everdingen, "The Skin Effect and its Influence on the Productive Capacity of a Well," Trans. AIME (June, 1953).
[2] William Hurst, "Establishment of the Skin Effect and its Impediment of Fluid Flow into a Well Bore," *Petroleum Engineer* (Oct. 1953).
[3] J. J. Arps, "How Well Completion Damage Can Be Determined Graphically," WORLD OIL (April 1955).
[4] John P. Dolan, Charles A. Einarsen, and Gilman A. Hill, "Special Applications of Drill Stem Test Pressure Data," AIME Paper 851-G, Billings, Mont., May 23, 24, 1957.
[5] D. R. Horner, "Pressure Build-up in Wells," Proceedings of the Third World Petroleum Congress, Section II, E. J. Brill, Leiden, Holland (1951).

About the Author

Dr. H. K. van Poollen heads the reservoir engineering section of Halliburton Oil Well Cementing Company's chemical research laboratory at Duncan, Okla. With Halliburton since 1955, his work deals with formation testing, secondary recovery and well stimulation. Dr. van Poollen graduated from the Technical University of Delft (Holland) in 1948 with a bachelor of science degree in mining engineering. He then studied at the Colorado School of Mines and received his masters degree in 1950. Following service in the Dutch army and three years in Indonesia for Standard-Vacuum Oil Company he returned to the Colorado School of Mines and was awarded his doctorate in mining engineering in 1954.

FIGURE 1 FIGURE 2

Photograph at left shows seriousness of gyp accumulation on a traveling valve from a West Texas well. Cutoff section of tubing at right was pulled from another West Texas well and shows extent of gyp buildup.

What Can Be Done About Gyp Depositions?

Use of polyphosphates mixed with sand and oil of a conventional fracturing treatment has prevented mineral deposition and increased production.

By Anthony Gibbon, WORLD OIL Staff

ACCUMULATED "gyp" deposits in and near the well bore and on downhole well equipment have been a serious problem in many oil wells. Preventive treatments using a 12-to-40 mesh granular polyphosphate, injected into the producing formation during fracturing treatments, have successfully reduced such mineral deposition. Although more than 150 treatments have been conducted, many of them have been so recent that their long-range effect on a well's production cannot yet be determined. However, wells that have been producing six months or more since treatment show that such polyphosphate sequestering agents are highly effective in preventing mineral deposition.

Effects of Gyp Deposits. In many wells, accumulated gyp deposits on downhole well equipment are heavy enough that pumps must be pulled every 30 days. Figure 1 shows the extent of scale accumulations on a mud anchor from a West Texas well. Deposits in the tubing from another well in the same area can be seen in Figure 2. Mineral deposits here have greatly reduced the tubing's flow capacity.

Unexplained production declines may be caused by mineral deposition. Frequently, an oil well that was completed and tested for good initial production rate declines rapidly. The cause for such a decline is not apparent, and the production zone is known to contain large amounts of oil. Plugging of formation flow channels by gyp deposits in and near the well bore may cause such declines.

These deposits usually consist of calcium carbonate, calcium sulfate, or barium sulfate. Deposition of such mineral scales may be caused by changes in reservoir equilibrium near the well bore, or, in open-hole completions, by the mixing of incompatible brines from different formations.

If these deposits contain enough carbonate, they can be dissolved or disintegrated by acidizing. When the deposit consists principally of sulfates, fracturing the well is usually the only effective remedy.

Use of Polyphosphates. The granular polyphosphate used to retard mineral deposition acts as a sequestering agent. It inhibits crystal growth so that insoluble compounds such as calcium carbonate, calcium sulfate, and barium sulfate remain in colloidal suspension until after they are produced from the well.

The polyphosphate is simply injected into the formation by mixing with the sand used in conventional fracturing treatments. There, the polyphosphate is slowly dissolved by

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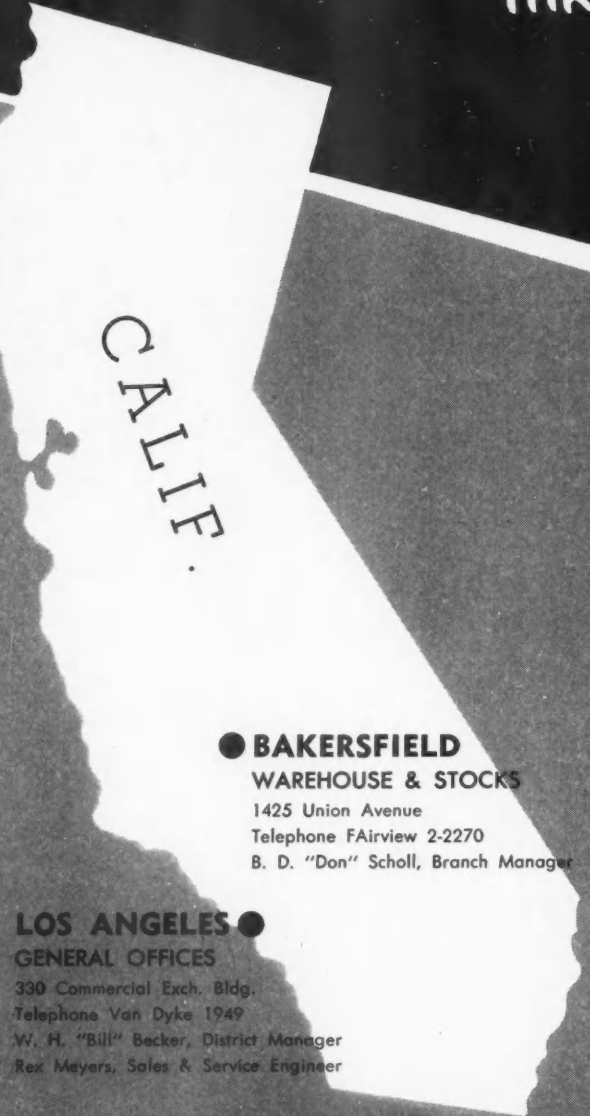

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TABLE 1—Results of Fracturing Treatments Using Polyphosphate Sequestering Agent

Well No.	OIL/WATER PRODUCTION DURING MONTHS PRIOR TO TREATMENT												TYPE OF TREATMENT				PRODUCTION (OIL/WATER) FOLLOWING TREATMENT					
	12	11	10	9	8	7	6	5	4	3	2	1	Fluid	Gallons	Sand (Lb.)	Polyphosphate (Lb.)	1	2	3	4	5	6
A	.....	118/4	.....	.....	84/2	.....	.....	39/1	.....	.....	35/1	.....	Oil	40,000	40,000	500	.....	112/2	112/2	112/2	.....	.....
B	.....	.....	.....	31/93	.....	.....	.....	.....	11/14	.....	.....	25/35	Oil	1,500	1,500	200	.....	25/35	25/35	.....	.....	.....
C	7/0	6/0	7/0	6/0	6/0	7/0	7/0	6/0	6/0	5/0	5/0	2/0	Oil	12,000	12,000	300	14/10	56/40	16/12	16/11	16/11	.....
D	35/1	34/8	35/9	36/9	34/8	34/8	23/6	26/4	25/4	23/4	29/5	25/3	Acid	500	1,200	500	63/94	65/44	55/85	63/93	77/26	.....
E	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	and Oil	3,000	.....	.....	.....	.....	.....	.....	.....	.....
F	12/1	12/0	14/1	25/44	25/52	45/16	18/14	5/10	8/9	6/7	5/9	15/15	Oil	1,000	4,000	300	20/8	20/566	20/6	20/5	17/3	.....
	.....	.....	.....	31/0	20/0	26/0	30/0	13/0	20/0	24/0	16/0	8/0	Acid	3,000	3,000	500	20/0	12/0	26/0	21/0	.....	.....
G	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	and Oil	3,000	.....	.....	.....	.....	.....	.....	.....	.....
H	.....	.....	5/0	.....	.....	.....	1/0	.....	.....	6/1	.....	.....	Water	10,000	5,000	300	57/30	27/4	29/2	.....	.....	15/4
I	.....	.....	.....	206/111	.....	.....	.....	3/19	.....	.....	5/1	.....	Water	10,000	5,000	500	69/124	41/118	32/180	.....	.....	.....
J	.....	.....	62	.....	.....	.....	.....	.....	9	.....	.....	4	Water	10,000	5,000	300	146/17	85/11	.....	107/9	36/129	75/5
K	.....	5/0	.....	.....	.....	1/0	.....	.....	6/1	.....	.....	6/1	Water	10,000	5,000	300	61/4	55/1	.....	.....	18/1	12/½
	.....	.....	27/0	.....	13/0	.....	3/0	60/5	41/0	31/3	30/0	24/13	Oil	6,000	12,000	410	90/1	30/3	47/2	49/0	.....	.....

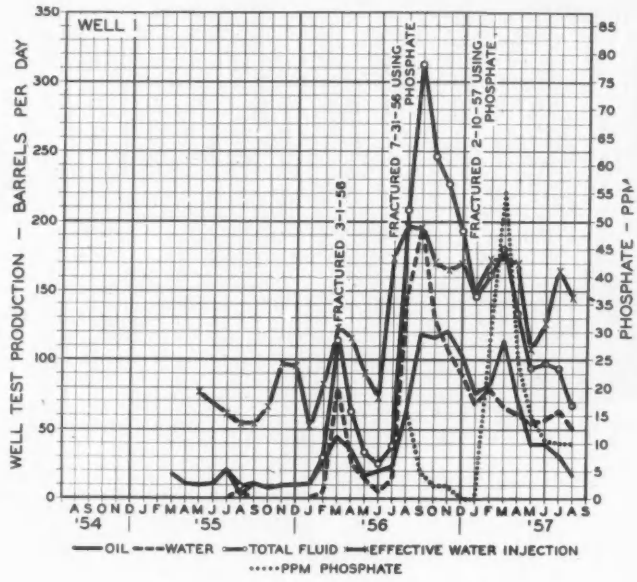
WELL 1
WELL TEST PRODUCTION – BARRELS PER DAY
PHOSPHATE – PPM
FRACTURED 3-1-56
FRACTURED 7-31-56 USING PHOSPHATE
FRACTURED 2-10-57 USING PHOSPHATE
A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S
'54
'55
'56
'57
OIL WATER TOTAL FLUID EFFECTIVE WATER INJECTION
PPM PHOSPHATE

FIGURE 3

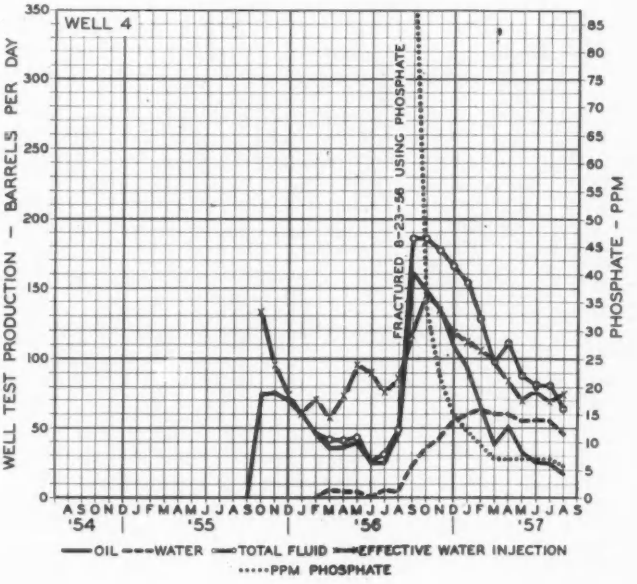
WELL 4
WELL TEST PRODUCTION – BARRELS PER DAY
PHOSPHATE – PPM
FRACTURED 8-23-56 USING PHOSPHATE
A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S
'54
'55
'56
'57
OIL WATER TOTAL FLUID EFFECTIVE WATER INJECTION
PPM PHOSPHATE

FIGURE 6

produced well fluids, preventing mineral deposition within the formation and on downhole well equipment.

Production Results. Table 1 shows the sustained production and gradual declines that resulted after wells previously having gyp problems were treated with polyphosphate. Although some of these wells have been fractured too recently to obtain conclusive results, definite trends can be seen.

Well A was seriously affected by gyp deposits. Eleven months before the polyphosphate fracturing treatment, production was 118 barrels of oil per day and 4 barrels of water per day. Only three months later, formation plugging had reduced production to 84 bopd and 2 bwpd. Two months before the treatment, production was down to 35 bopd and 1 bwpd. Following the polyphosphate treatment, production has remained level at 112 bopd and 2 bwpd through a four-month period, with no evidence of troublesome scale deposits.

A similar situation existed in Well B. Before the fracturing treatment using polyphosphate, scale deposits

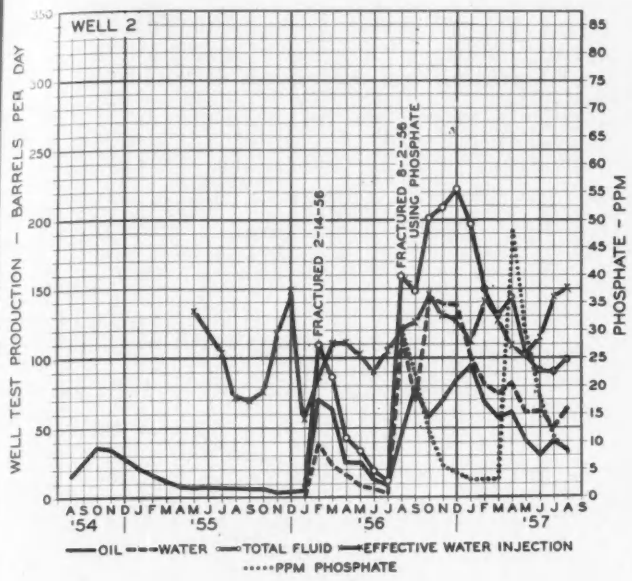

FIGURE 4

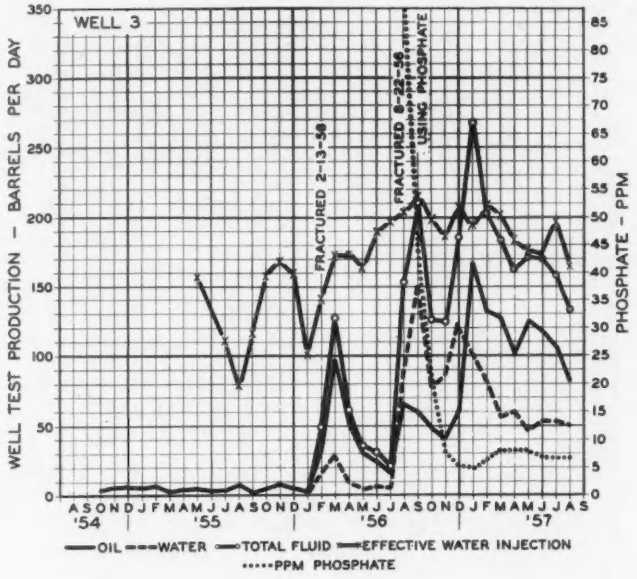

FIGURE 5

Figures 3 through 7 show the production histories of five secondary recovery producing wells all treated with polyphosphate. Well 1 was treated with 200 pounds; Well 2 was treated with 400 pounds; the other three wells with 600 pounds each. The polyphosphate was injected with 5000 gallons of oil and 10,000 pounds of sand in each well. Gyp deposition had been a serious problem in all these wells. All wells except Number 4 showed good production increases when production stabilized after treatment.

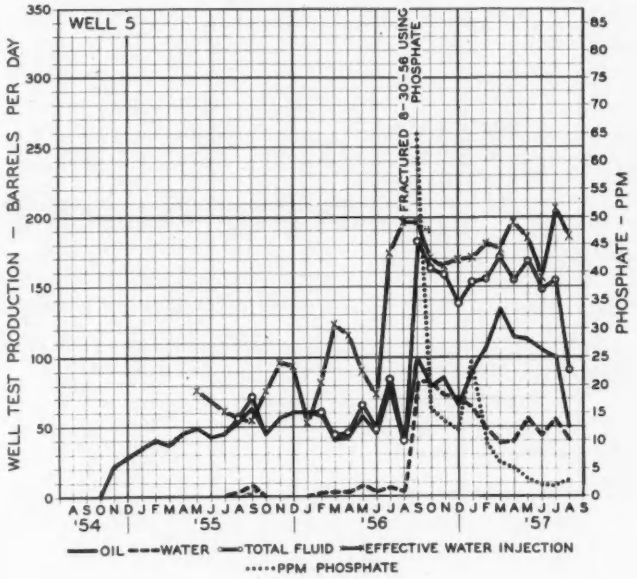

FIGURE 7

accumulated so rapidly that it was necessary to pull the pump equipment every 30 days. Since the treatment, pulling has been eliminated.

Well C produced only 5 to 7 bopd during the 12 months before a polyphosphate treatment. Afterwards, the well produced an average of 14 bopd the first month, 56 bopd the second month, and 16 bopd during the last three months for which data are available. In this case, mineral deposition in the formation near the well bore apparently constricted flow channels, reducing production. The sequestering action of the injected polyphosphate was so effective that production leveled off at more than twice that during the 12 months before the treatment.

Other wells in Table 1, all of which are primary production wells, similarly show how gyp deposition problems have been mitigated by using polyphosphate sequestering agents.

Figures 3 through 7 are graphs showing the production history of five secondary recovery producing wells treated with polyphosphate. In each case, the polyphosphate was injected with 5000 gallons of oil and 10,000 pounds of sand. Two hundred pounds of polyphosphate was used in Well 1, 400 pounds in Well 2, and 600 pounds each in the other three wells. The phosphate content of produced water was determined before and after the fracturing treatments.

These five wells are all on a lease where gyp deposition has been a serious problem. Wells 1, 2, and 3 were fractured conventionally before the

Continued on Page 148

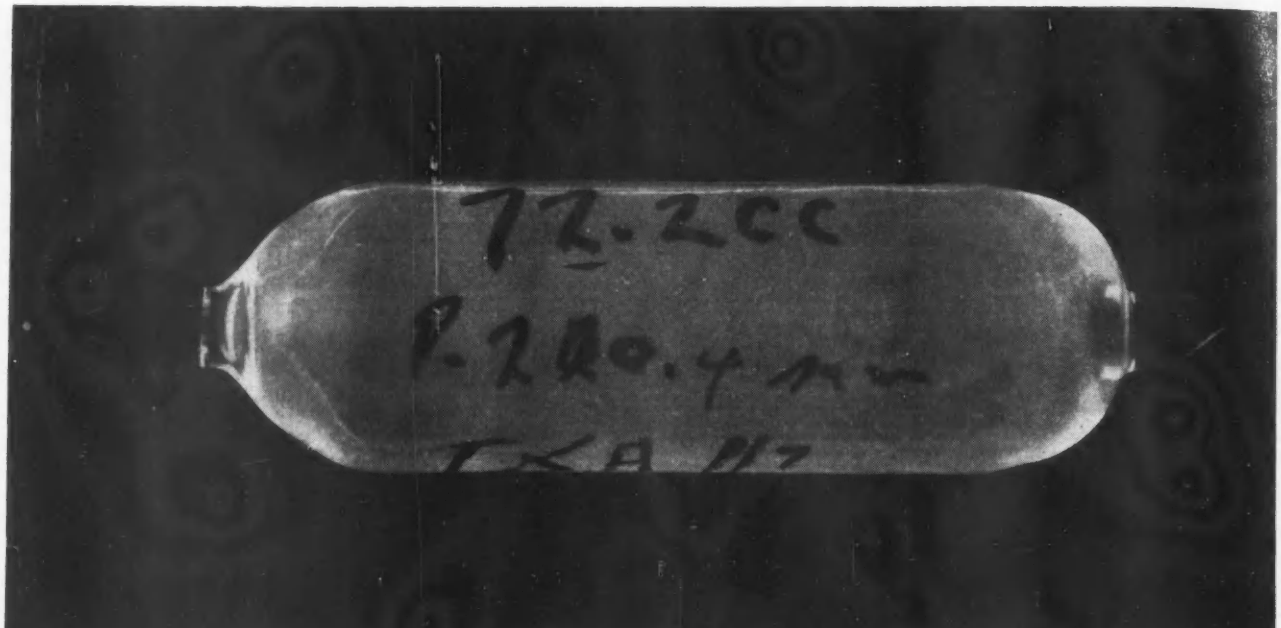

FIGURE 1—This glass ampoule contains 50 curies of tritium, enough to tag 20 billion cubic feet of gas. Photo was made by the visible light emitted from this radioactive element.

Tritium—Newest Tool for Tracing Reservoir Flow

Non-toxic, low order beta ray emission, ready availability and safety make this isotope of hydrogen ideal for tracer work.

By Robert E. Fearon
Electrochemical Laboratories, Incorporated, Tulsa

THE USE of radioactive hydrogen (tritium) for tracing reservoir fluid movement has given the oil industry a valuable new research tool. Petroleum engineers are hampered in their efforts to obtain maximum recovery of underground oil and gas reserves by lack of accurate data on reservoir flow characteristics and patterns of fluid migration. Such fluids can now be labeled with radioactive hydrogen and traced accurately throughout the reservoir.

The development of nuclear science has profoundly affected American business and industry. Of the many results of atomic research having useful applications in industrial processes, radioactive materials are among the most important. Between 800 and 1000 synthetic radioactive materials are now available. From them, substances with practically any desired radiation intensity and duration can be chosen. In contrast with exorbitantly expensive naturally occuring radium, previously one of the few practically available radioactive substances, many of these new, artificially produced radioactive isotopes are fairly inexpensive. They furnish the engineering profession a valuable, hitherto unavailable research tool.

The oil industry has been foremost among the many industries that have benefited from the application of radioactive isotopes. Oil companies have employed radioactive tracers in many ways, not only in conducting subsurface surveys, but in tracing and analyzing refinery operations. One important application has been in analyzing fluid migration in oil and gas reservoirs. This use is especially valuable in secondary recovery water flood projects for determining flood patterns and detecting undesirable channeling between input and production wells.

Radioactive Tracers. A radioactive element consists essentially of unstable atoms which break down, at a characteristic rate, into a more stable element. This decay is accompanied by the emission of energy, in the form of radiation, which can be detected by geiger counters, scintillation counters or other suitable electronic devices. Of the many artificially produced radioactive substances now available, tritium and krypton have been found best adapted to oil field tracing operations.

Radioactive krypton, an isotope with an atomic weight of 85, is an inert gas. As such it can be mixed with other gases for tracing operations in gas reservoirs. It blends, but is not identical, with the traced gas. It does not readily separate out, however, and can be detected easily by means of geiger counters.

Tritium, an isotope of hydrogen, has an atomic weight of 3, in comparison with an atomic weight of 1 for normal hydrogen and 2 for deuterium, or heavy hydrogen. It can be derived from the operation of chain reaction piles, and is available from the U.S. Atomic Energy Commission or similar organizations in other countries that market radioactive materials (Figure 1).

The isotope tritium has a number of unique advantages not shared by

other radioactive tracing agents. In addition to its low cost, it has the advantage of safety in handling. This is because its radiation consists of a low order beta-ray emission that does not present a particularly dangerous health hazard to those handling the material. The toxicity of tritium, for example, is of the order of 0.0001 that of a corresponding amount of strontium-90.[1]

In addition to its ready availability and safety, a unique advantage of tritium is that it is chemically identical with hydrogen. This is important because hydrogen is a component of many thousands of different compounds. Tritium can form an integral part of any compound containing hydrogen, thus such compounds can easily be "tagged" for study purposes. For example, when tracing water migration, synthetically-prepared water containing tritium is blended into the natural brine. Similarly, synthetically-prepared methane or petroleum hydrocarbons, containing tritium, may be used to trace the movement of their non-radioactive analogs (Figure 2). Such radioactive markers have the advantage of being chemically identical with the material they are tracing. Thus they are not liable to separation by any chemical or physical agency, under usual reservoir conditions.

Another advantage of tritium is that it is comparatively stable, with a half life of about 12 years. At the same time, tritium's low level of radio activity prevents it from becoming an appreciable health hazard at some later date.

"Radiocarbon Age" Apparatus. The use of extremely low-level radioactive material as a tracing agent has been made possible by the use of the rare and extremely sensitive radiocarbon detection apparatus to monitor production samples. This apparatus, of which only 20 are known to exist at the present time, utilizes specially designed geiger counters of extreme sensitivity which measure radiation of gaseous samples at atmospheric pressures. It was originally designed by W. F. Libby, professor of physics at Chicago University, now on leave as member of the Atomic Energy Commission.

The counter is constructed of the most non-radioactive materials available, and is comprised of methacrylic plastics, steel and carbon elements

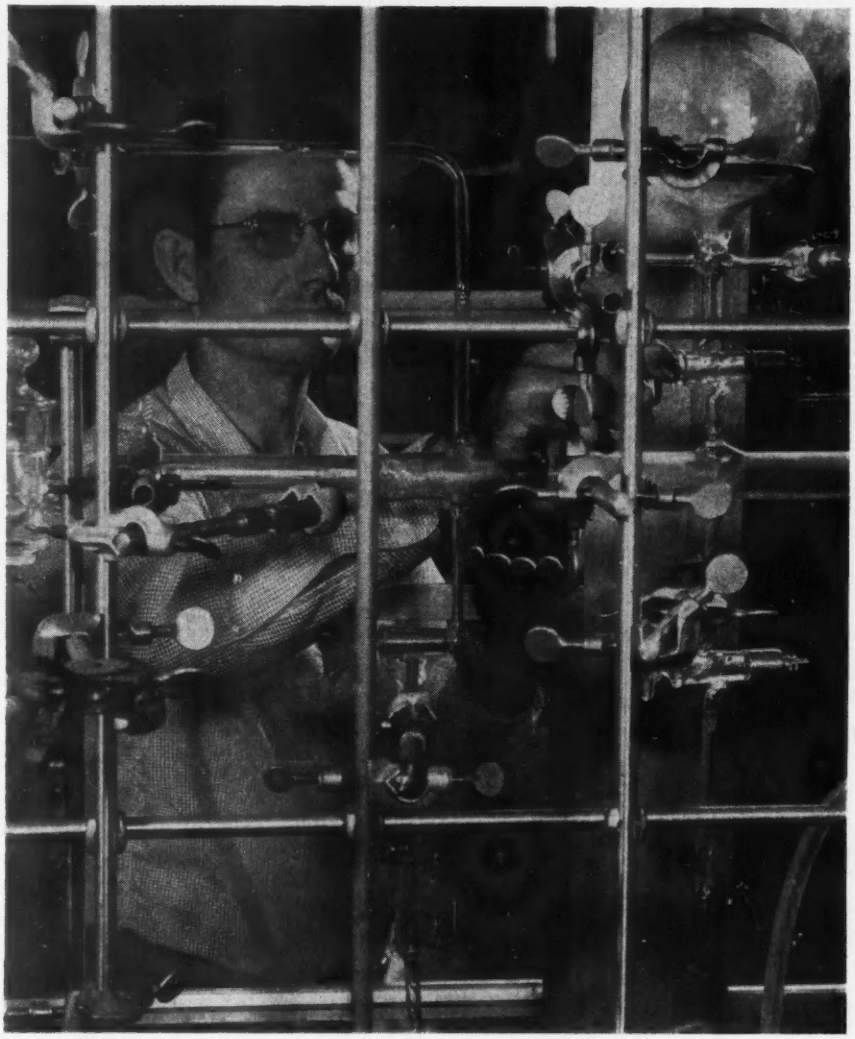

FIGURE 2—Chemical compounds, identical with the fluid to be traced, are synthesized in the laboratory using radioactive hydrogen (tritium) as a constituent.

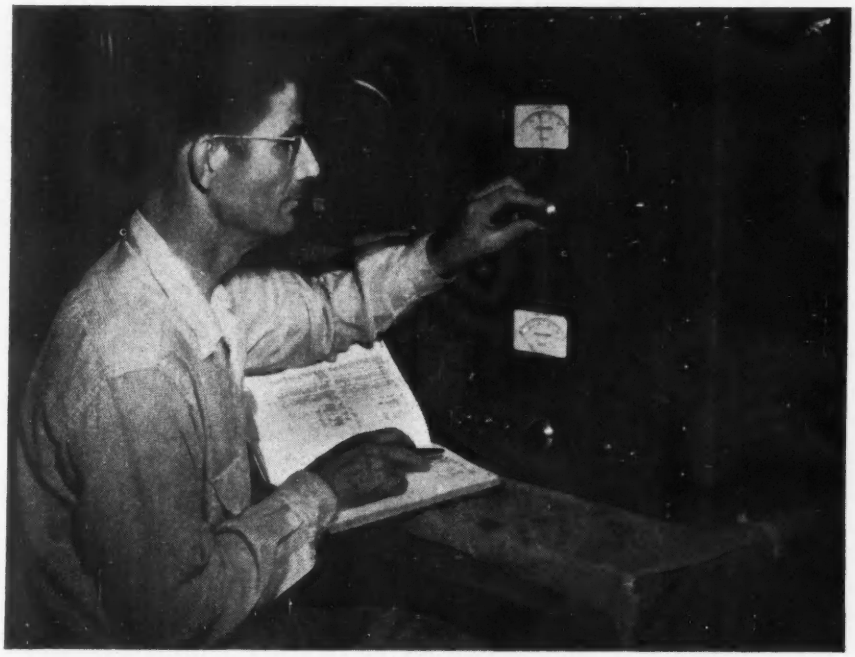

FIGURE 3—The author is shown seated at the controls of the Libby-modified geiger counter used to assay samples from reservoir tracing operations.

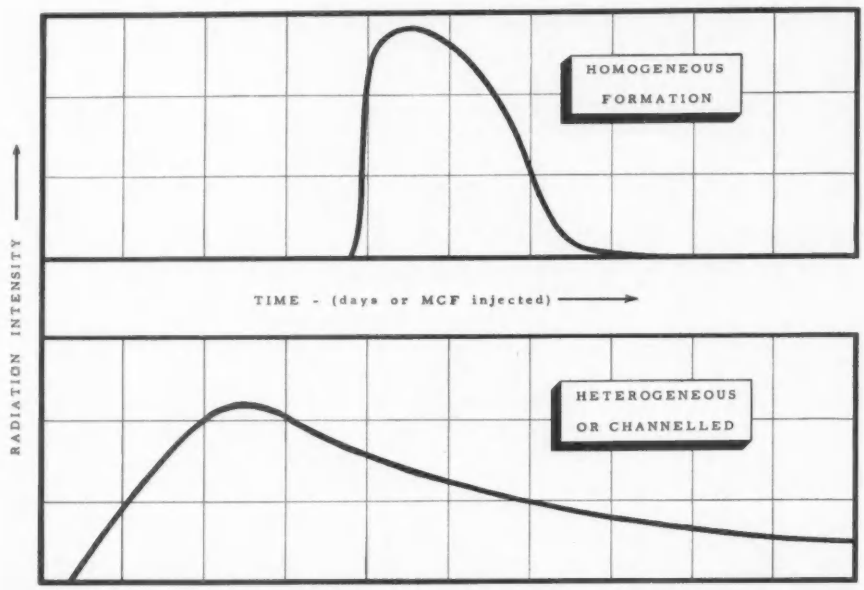

FIGURE 4—The time required for the "tagged" tracer compound to travel from the injection point to a producing well gives valuable data about reservoir flow characteristics.

only. No common glasses are used because most types contain appreciable amounts of potassium, which is slightly radioactive. This counter is surrounded by more than 1000 pounds of shielding material, which prevents stray outside radiation from striking it.

The influence of external radiation from cosmic ray mesons and other ionizing, vertically travelling particles of the cosmic ray variety is prevented by the counter's specialized design.

In effect, the level of radioactivity in the counting chamber is similar to that which would be found in a pure limestone cave, 3000 feet underground. These various precautions are particularly important because the normal laboratory environment contains an appreciable level of radioactivity which would increase the apparent radioactivity of the sample being assayed, thus reducing the accuracy of the determination.

Radiation is measured in terms of the number of atoms undergoing atomic disintegration per unit time. Specifically, a curie is defined as 3.7×10^{10} atoms disintegrating per second. The Libby modified geiger counter is capable of detecting a minimum of 3×10^{-16} curies per cubic centimeter of gaseous sample at normal temperature and pressure. This is about 20,000 times less than the number of curies of naturally occurring radioelements in a cubic centimeter of average concrete.

The reason that Libby modified geiger counters are so rare is that such an extreme degree of sensitivity is not needed in most applications. It is interesting that a similar apparatus was used for radiocarbon age determinations on fragments of material from the recently discovered Dead Sea scrolls. In this application, the material being tested was transformed chemically into suitable form for radioactive measurement of the presence of carbon-14, which exists to some extent in all naturally occurring objects. The radioactive carbon content of the Dead Sea scrolls when they were new was estimated and compared with their measured present radioactivity level. Their age was then established by computing the time required for radioactive carbon-14 to decay to such a degree.

Field Procedures. Fluid flow in reservoirs is traced by injecting radioactive tracer material into the producing zone, allowing it to flow through the reservoir intermixed with natural formation fluids, and determining the length of time required for it to travel from the injection well to other desired check points or wells in the field. Periodic samples are taken from such wells at different intervals of time following the injection and analyzed by means of the Libby modified geiger counter apparatus, which measures the amount of tritium present in the sampled fluid.

A number of precautions must be taken if the results obtained are to be valid and not misleading. First, the tritium should be presented in a chemical form which will mix homogeneously with the fluid being traced. This presentation insures uniformity of tracer concentration in the formation fluid being traced and prevents physical separation or plating-out of the radioactive element on the formation through which it passes.

The tracer is suitably diluted, prior to injection, so that it may mix uniformly through the gas or liquid being traced. If the tracer is concentrated in a relatively small portion of the formation fluid, there is danger that it may bypass the check point entirely. If the well into which the tritium is injected is normally a producing well, it should be shut in long enough following the injection for the tritium to be moved away from the well bore by the normal flow of formation fluid. If production were immediately restored, the tracer material might be drawn back into the well and produced from it instead of flowing through the normal formation flow channels as desired.

The radioactive tracer material is

About the Author

Robert E. Fearon received his B.S. and M.S. degrees from the University of Pittsburgh in 1933 and 1934. He also held a Graduate Council scholarship until 1936. He joined Schlumberger Well Survey Corp. in 1936. In the following years he served as research engineer at Engineering Laboratories, and with Well Surveys, Inc., and Stanolind Oil and Gas Company. In 1952 he founded Electrochemical Laboratories of which he is now president. His membership societies include the American Chemical Society, American Physical Society, American Geophysical Union, Society of Petroleum Engineers of AIME, Society of American Military Engineers and the Society of Exploration Geophysicists. Fearon holds many patents in the fields of nuclear radiation measurement and well survey services, and he has contributed frequently to scientific journals.

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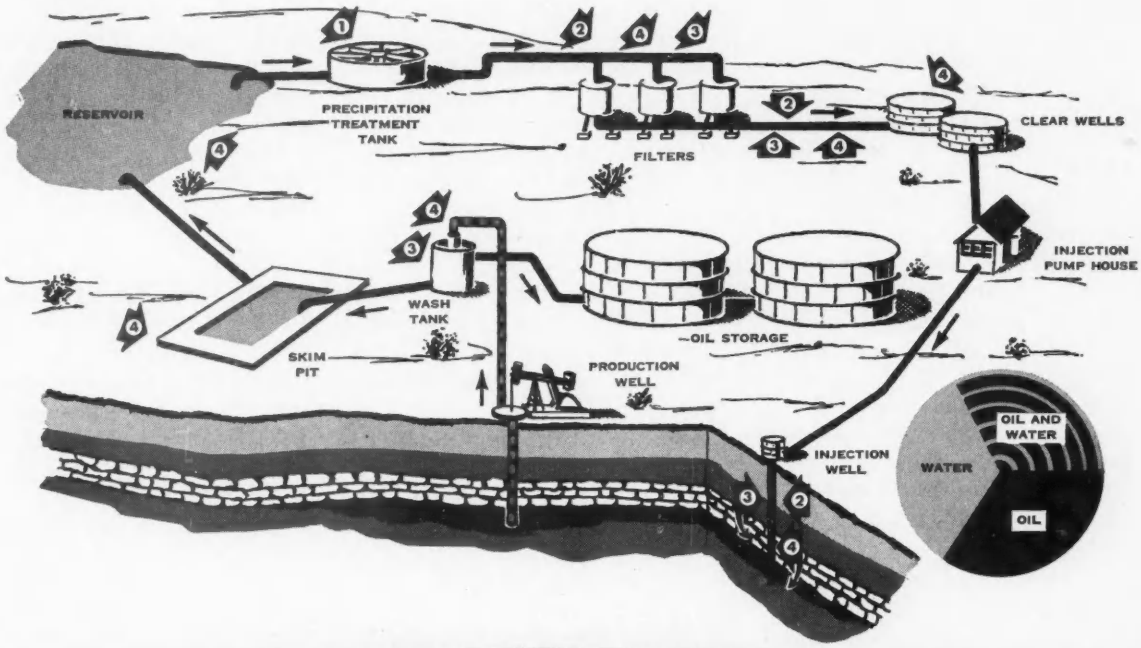

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introduced into the wellhead by a special injection system. The system consists of an entrainment vessel that contains the tritium. The vessel is connected at one end to the wellhead and at the other end to a pressure source for injecting either gas or liquid, as the case may be. Suitable valves and pressure gages control the flow of fluid through the entrainment vessel. When the valves are open, the liquid or gas under pressure passes through the vessel into the wellhead mixing with and carrying along the radioactive tracer material. Additional fluid follows to flush the radioactive material down the well bore and into the formation.

Samples are then taken, at various time intervals, from selected check points throughout the field. These samples are suitably confined in either glass bottles (for liquids) or breathing oxygen tanks at 60 psi (for gases). The samples are then shipped to the laboratory, where their radiation level is checked in the Libby-modified geiger counter apparatus.

If the sample to be assayed is gaseous, it can be measured directly. If the sample consists of water or hydrocarbon, it is processed chemically to release its hydrogen in gaseous form, after which the presence and concentration of the tritium component can be readily measured.

From a series of assays of such samples, it is possible to determine both the time required for the tracer material to pass from the injection point to the producing point, and the amount of mixing or dilution that occurs in the formation. If the tracer material arrives in a relatively sharply defined increment, it indicates that comparatively homogeneous flow is taking place in the reservoir. If, however, the tracer is diffused over a considerable quantity of formation fluid, a strong possibility of channeling or heterogeneity within the formation is indicated. This may be seen in Figure 4.

International Use. Radioactive isotopes have been used for tracing reservoir flow patterns in a number of oil fields in the U.S.[2,3] In addition, radioactive tracing operations have been conducted by Creole Petroleum Corporation of Caracas, Venezuela.

This oil company has embarked upon an extensive conservation program in Venezuela. The total cost of this program is expected to reach about $175 million by the end of 1960. This repressuring project involves collecting gas and re-injecting it into the producing formation. The program will eventually include three compression plants in San Joaquin in eastern Venezuela, three in Lake Maracaibo, an LPG plant in Tia Juana, and an elaborate gas-gathering system in the Bolivar coastal fields.[4]

The first phase of this program, conservation plant Tia Juana No. 1, has been in operation approximately two years. During this time, an average of 137 Mmcf of gas per day was injected into the LL-370 reservoir. As a result, 8,800,000 barrels of additional oil and 1,500,000 barrels of compression condensate have been recovered with approximately 100 billion cubic feet of gas conserved for future use.

Before embarking upon this rather ambitious undertaking, Creole conducted an extensive engineering study of the reservoirs involved. This not only included determining the areal extent of the reservoirs, but also a study of fluid migration within the reservoir in order to evaluate the probability of success of the proposed gas injection system. Accordingly, tracing operations were conducted involving the injection of tritium into the reservoir, and recording the arrival of the "tagged" gas at various distant wells. For use in this project, Creole has another of the rare Libby-modified geiger counters in its laboratories at Tia Juana. The result of this study materially assisted the company in planning and carrying out this gas-conservation program. Additional tracing operations are currently being conducted, using krypton-85 as a tracing agent, to test the efficiency of Creole's pressure maintenance program.

Radioactive tracers for analyzing the mechanics of reservoir flow are still fairly new as a research tool. Undoubtedly, much valuable information will be obtained from their use, probably leading to more complete recovery of the world's presently recognized oil reserves.

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[1] *Handbook 52*, U. S. Bureau of Standards, (estimation based on data shown in Table 3, page 15).
[2] "Super Sleuths Trace Flow of Injected Gas," by H. J. Welge, *Oil and Gas Journal*, August 29, 1955.
[3] "Oklahoma's Fractured Viola Limestone Reservoir," by Everett Skarda, *Oil and Gas Journal*, February 27, 1956.
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Gyp Deposition

Continued from Page 143

first fracturing treatment in which polyphosphate was used. The decline curves of these wells show that the use of polyphosphate improved production. The declines following fracturing treatments using polyphosphate are much more gradual than the curves following the conventional fracturing treatment. In fact, all wells except Well 4 showed substantial production increases after the original high production resulting from well stimulation. This shows that the sequestering agent prevented plugging of formation channels by mineral deposits. In addition, some existing deposits probably were removed.

Total production from wells on this lease was greatly increased by using polyphosphate. For example, estimated production from the conventional fracturing job on Well 1, extrapolated from the decline curve, shows 4500 barrels of additional oil produced during an 11-month period. This compares with 11,700 barrels of additional oil produced by Well 1 during the first 6 months following the special polyphosphate fracturing treatment. Estimated production for Well 2 during an 11½-month period following the conventional fracturing treatment was 5100 barrels, as compared with 9600 barrels in only six months following the polyphosphate treatment. During a similar 11½-month period after a conventional fracturing job, Well 3 produced an estimated 7300 barrels compared with 9100 barrels of oil produced during only five months following the special fracturing job.

On the entire lease, it was estimated that as of January 31, 1957, 13 regular fracturing jobs had produced 12,800 barrels of additional oil per well over a 10-month period. The five wells given special polyphosphate fracturing treatments had produced 10,200 barrels of additional oil per well in only 5½ months.

Examination of the pulling records for this lease also showed a marked improvement following the polyphosphate fracturing treatment. Previously, the average frequency of pulling jobs, for all wells on the lease, was 1.87 well-months. After the special fracturing jobs, this rose to an average of 3.35 well-months. —**The End**

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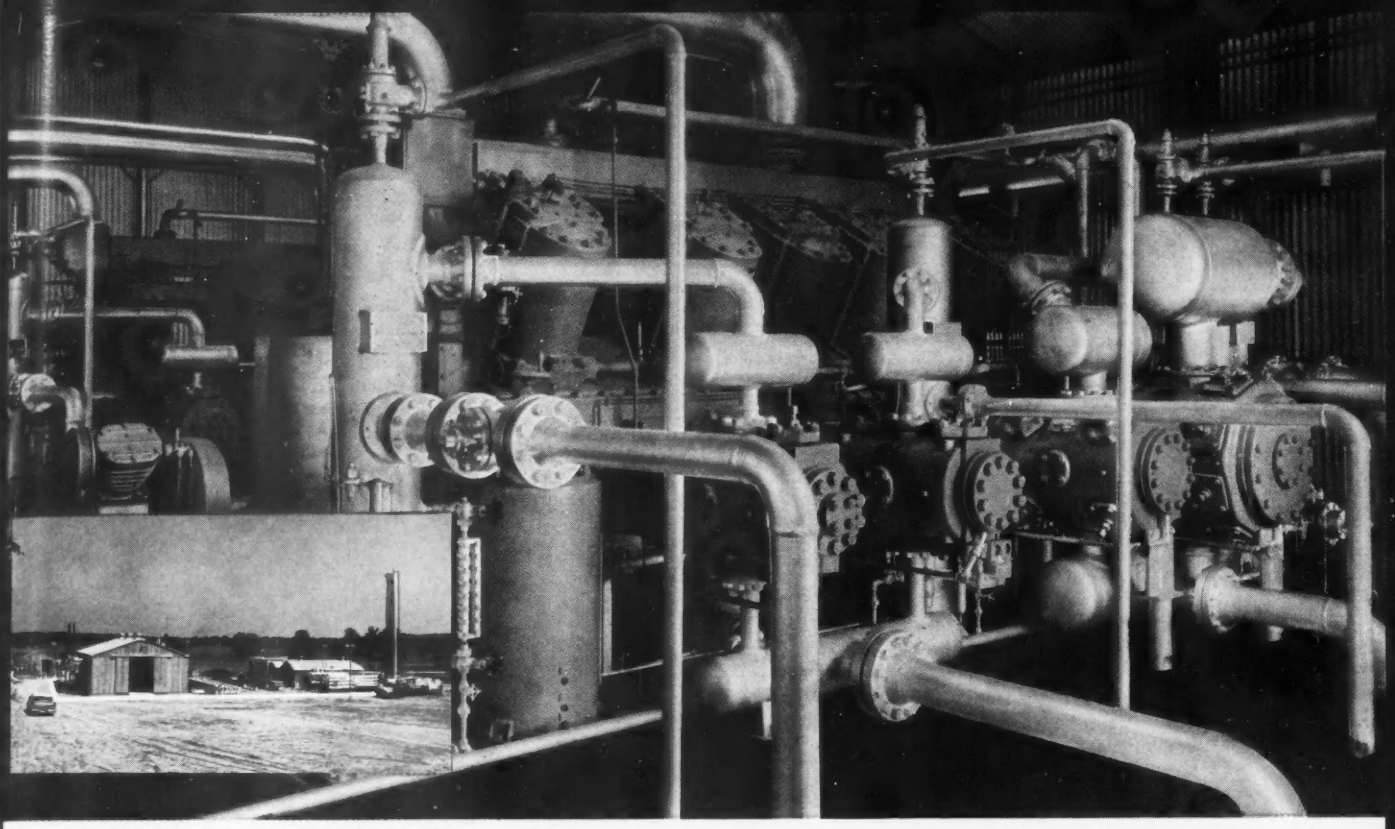

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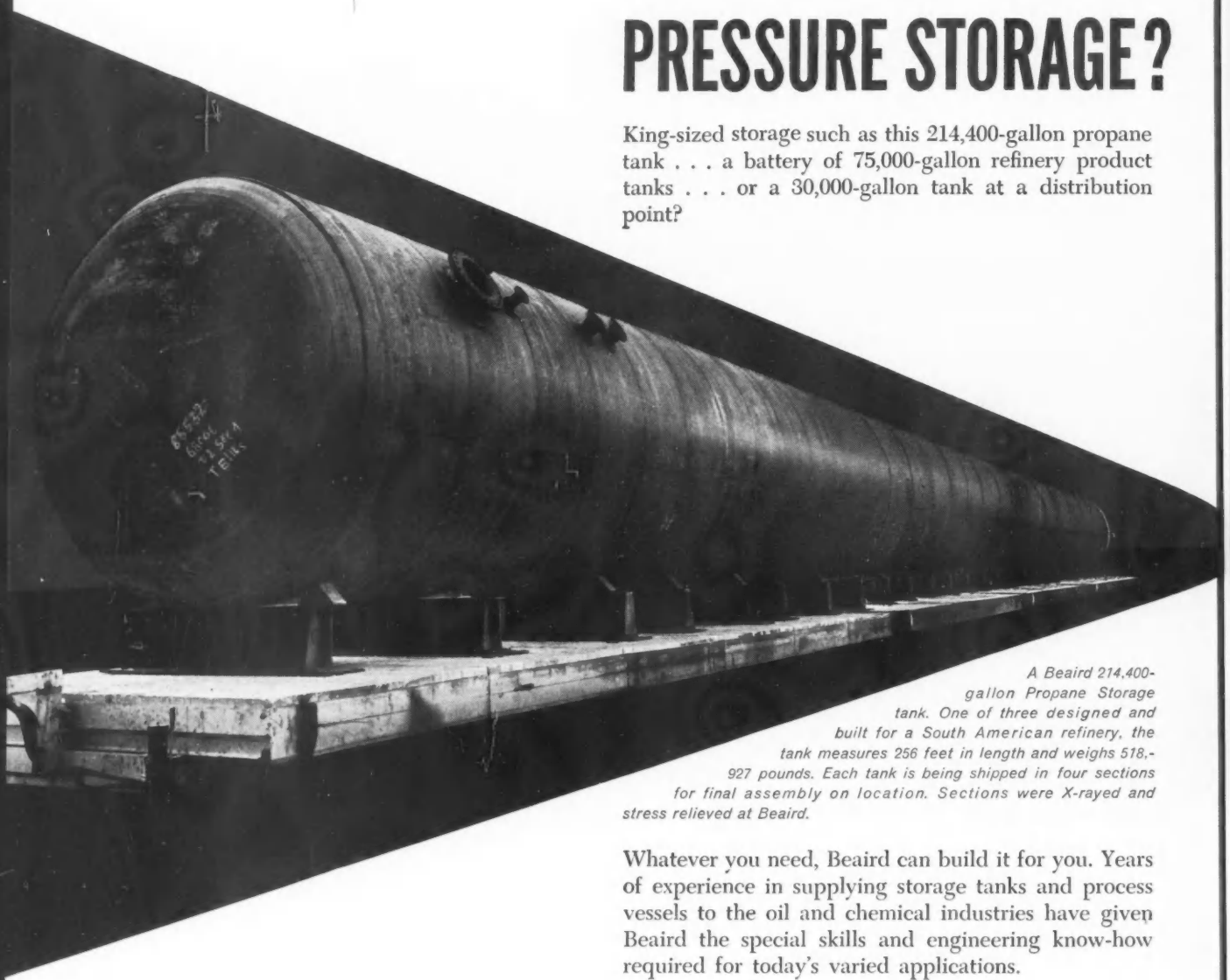

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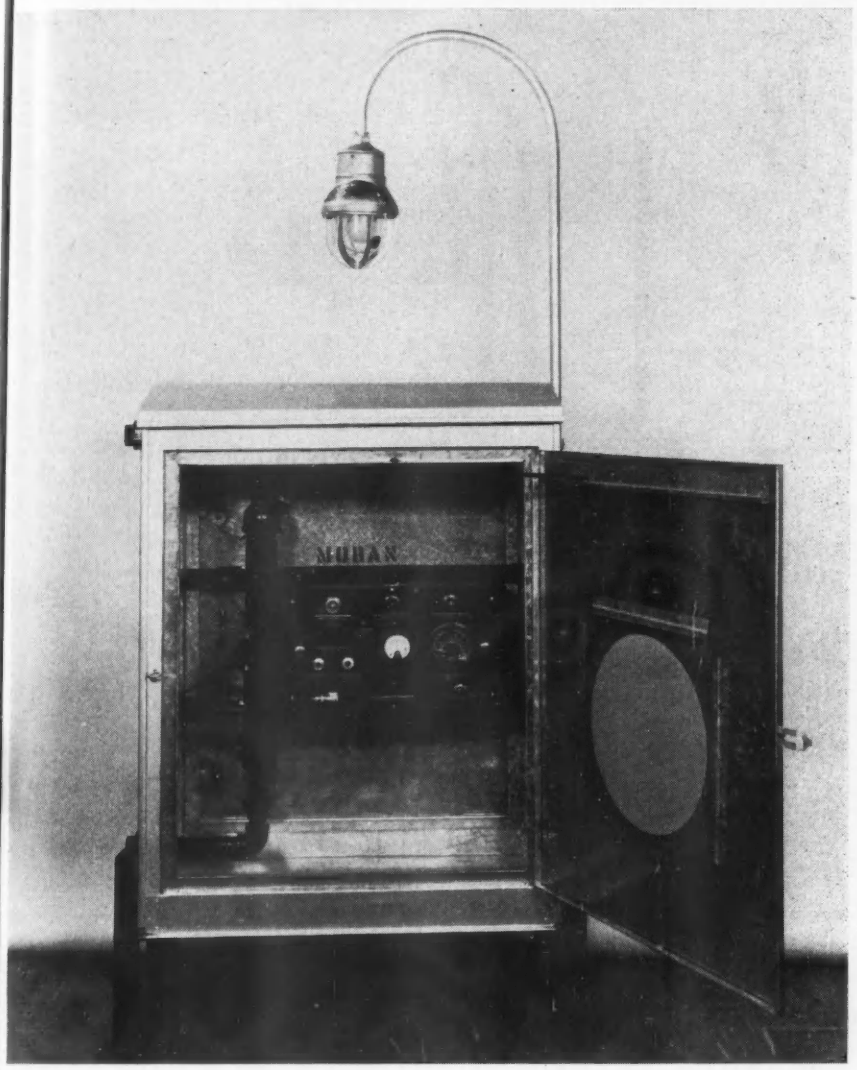


FIGURE 1—BS&W monitor and probe assembled in meter house.

Oil Field 'Watchman' Checks BS&W Content

This automatic monitor assures crude delivery at automatic tank battery within pipe line specifications.

By Howard J. EnDean
Gulf Research & Development Co., Pittsburgh, Penn.

ASSURANCE THAT CRUDE oil delivered to custody tankage is within pipe line specifications for basic sediment and water has been one of the major problems in development of automatic custody transfer facilities. Reproducibility of dielectric constants of crude oil contaminated with water has enabled the use of capacitance-sensitive instruments as a solution.

The monitor, a capacitance-sensitive instrument described hereafter, is an adaptation of the capacitance product analyzer, successfully used in pipe line and production operations for batch interface and BS&W recording. In custody transfer applications, the monitor continuously inspects the BS&W content of crude oil being delivered from the separator and/or treating equipment to tankage. On BS&W exceeding specification, the monitor will actuate control valves to reroute crude to wet oil storage or through treating equipment.

The monitor assembly, Figure 1, includes a pipe line probe and a control instrument. The probe, illustrated in Figure 2 is essentially a fixed capacitor, sensitive to changes in the dielectric constant of materials passing between the centrally located electrode and wall of the surrounding pipe.

Figure 3 shows the control instrument. Setting of the BS&W limit dial determines the BS&W content that will energize the control relays. The time delay unit shown can be set to allow a limited quantity of contaminated crude oil to pass to tankage where such deliveries are acceptable. Push buttons labeled current level check and operation check are for checking instrument operation and calibration.

The current level adjust dial, when used in conjunction with the current level check button, determines condition of the one radio tube in the assembly indicating when replacement is desirable.

The plug above the zero adjust label protects the calibration adjusting screw. Rotation of this screw shifts the calibration of the instrument to match the crude oil of a specific installation.

Three pilot lights located at the top of the instrument show whether the crude is within specification and what operation is taking place.

In a standard installation, the following would be an operating sequence. With acceptable crude oil be-

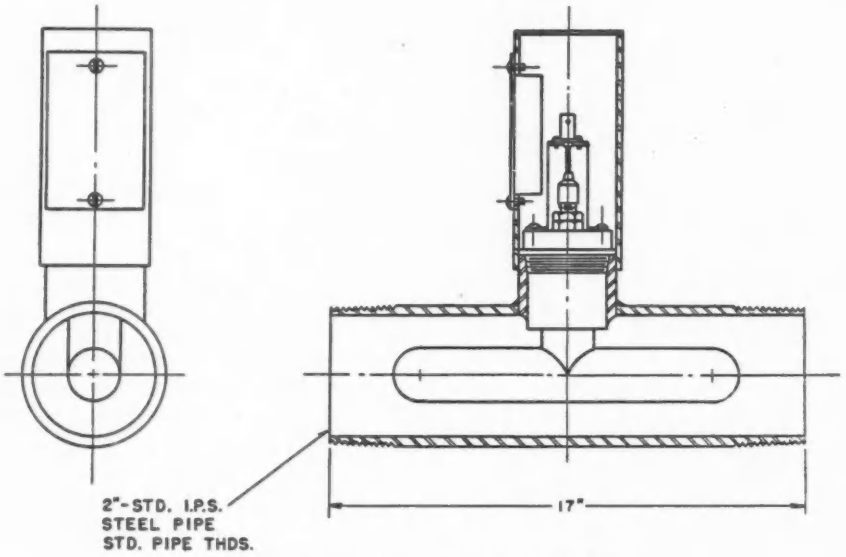


FIGURE 2—Standard bypass probe (2-inch).

ing delivered to tankage, the pilot labeled merchantable oil would be lighted. When the setting of BS&W limit dial is exceeded, the merchantable oil light goes out, and the excess BS&W light and time delay units are energized. If delivery of contaminated oil continues beyond the time delay setting, the excess BS&W light is extinguished and the oil by-passing light is energized. At the same time, relays are energized for valve operation and the warning light shown on the gooseneck of Figure 1 is lighted. When oil passing through the probe is again within specification, the relay controlled valves direct crude oil to tankage and the monitor is automatically reset.

The range of the monitor shown in Figure 2 is 0 to 3 percent BS&W with a 0 to 60-minute time delay. Both specifications can be varied to suit installation requirements.

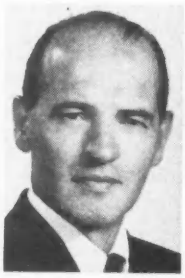
A typical calibration is shown in Figure 4. For BS&W ranges up to five percent, instrument response is essentially linear.

The effect of temperature variations on monitor calibration is illustrated in Figure 5. In developing data for this figure both probe and instrument were subjected to the temperature variations indicated. These test conditions are of maximum severity, since in most operations, crude oil temperature variations will be less than atmospheric. On the basis of these tests it is anticipated that with seasonal adjustment operation over a 0 to 3 percent BS&W range will be accurate to ± 0.1 percent BS&W.

The monitor system is illustrated by the block diagram, Figure 6. The instrument employs a crystal oscillator whose plate-parallel-tuned circuit consists of a probe (cylindrical capacitor) in parallel with a variable capacitor (adjusted by the BS&W limit dial), and a fixed inductance. A discontinuity or step takes place in the tube D-C plate current when the plate-tuned oscillator goes into, or out of, oscillation as a result of a change in

FIGURE 3—Front panel view of BS&W monitor.

About the Author



HOWARD J. ENDEAN attended Purdue University and Carnegie Institute of Technology, receiving a B.S. degree in metallurgical engineering in 1938. Since graduation, he has been employed successively by Standard Oil of Indiana, Engineering Laboratories, Inc., and Gulf Research & Development Company, his present employer, in the fields of drilling, production, pipe line, and reservoir engineering, with particular reference to the instrumentation and equipment associated with these four fields. He is a member of the AIME, and is a licensed professional engineer in the state of Pennsylvania.

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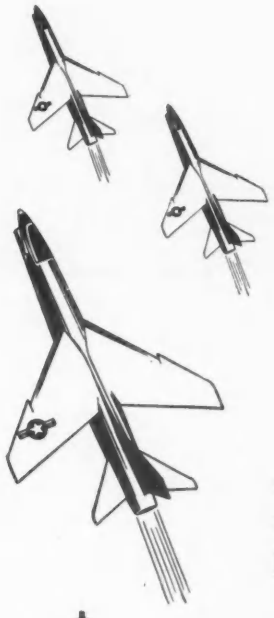

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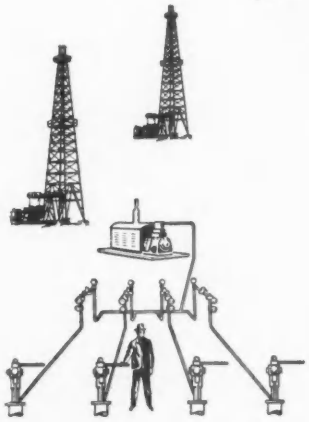

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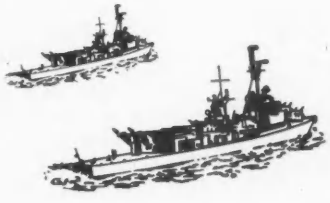

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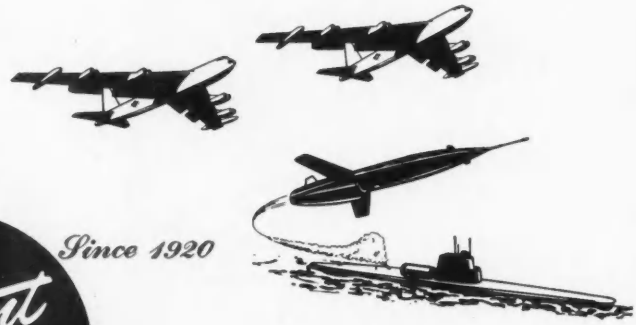

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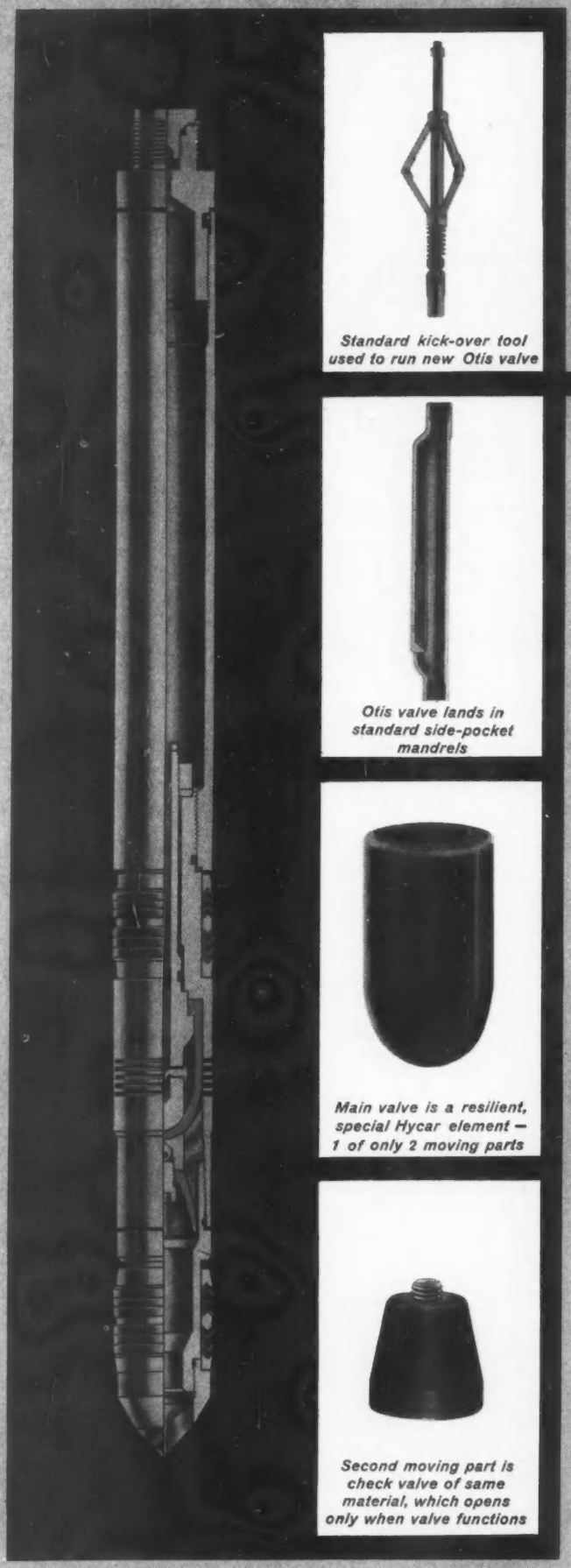

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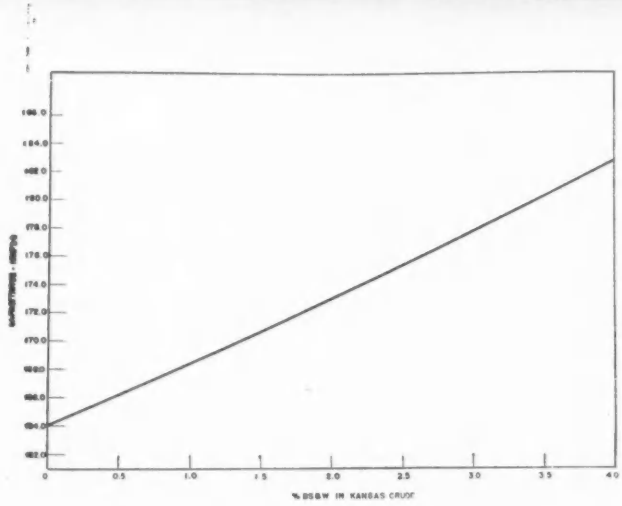

FIGURE 4—Calibration of BS&W monitor.

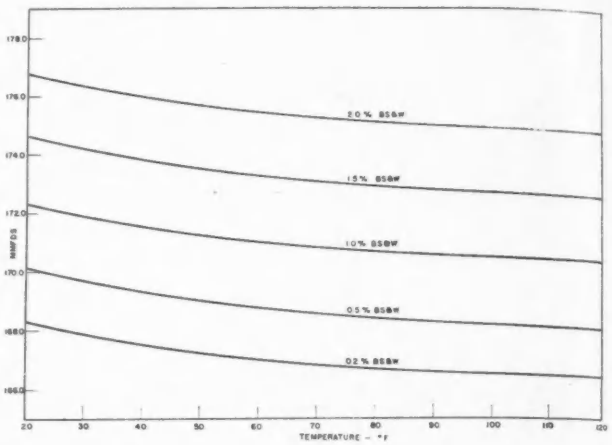

FIGURE 5—BS&W monitor calibration change vs. temperature.

the tuning of the plate circuit. This tuning is accomplished by the varying BS&W contamination passing through the probe.

With the tuned-plate circuit inductive compared to the natural frequency of the crystal (probe capacitance is small), the D-C plate current flow is low. As the probe capacitance is increased beyond the control point setting, the tube snaps out of oscillation and the D-C plate-current abruptly increases. A current-sensitive D-C relay on the tube plate circuit is energized by the abrupt increase in D-C plate current. This relay then energizes a time-delay component. If BS&W contamination persists beyond the time setting, circuit control relays are actuated. When BS&W is reduced below the control point indicated by the limit dial, oscillations are resumed and the D-C plate current decreases. This de-energizes the D-C plate circuit relay which in turn de-activates and automatically resets the time-delay mechanism.

How the monitor is applied to an automatic custody tank battery will depend upon arrangement of equipment and the function to be performed by the instrument. It is anticipated that a bypass type probe arrangement will be standard since it maintains turbulent flow in the probe and assures thorough mixing of fluids. This arrangement also permits maximum flexibility since the monitor may be placed at any location convenient to operations.

Application of a monitor in one type of automatic custody battery is shown in Figure 7. In this installation, crude oil adjacent to the outlet of the settling tank is continuously inspected. Excess contamination will be directed to the sump for rerouting through the treating system. An auxiliary control system is shown by dashed lines whereby the monitor can also be used for chemical pump injection control.

Another type installation is shown in Figure 8. In this application, oil from wells continuously producing BS&W contamination above pipe line specification goes directly to wet oil storage. This tankage delivers to a centrally located dehydration unit. Wells normally producing clean oil, which may at times produce water in excess of requirement, are directed through the line incorporating the monitor bypass. When contaminated oil exceeds the monitor setting for BS&W, the motorized control valve directs the non-specification crude oil to the wet oil tank. Rerouting to the clean oil tanks will be automatic when BS&W content is reduced to specification.

The first monitor installation for BS&W control in an automatic custody tank battery has been in operation for over one year. Several other installations have been made with

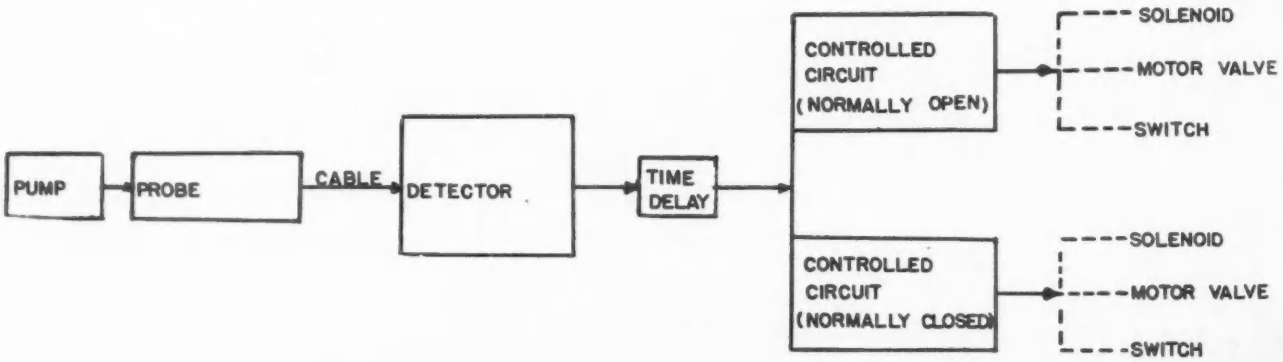

FIGURE 6—Diagram of BS&W monitor.

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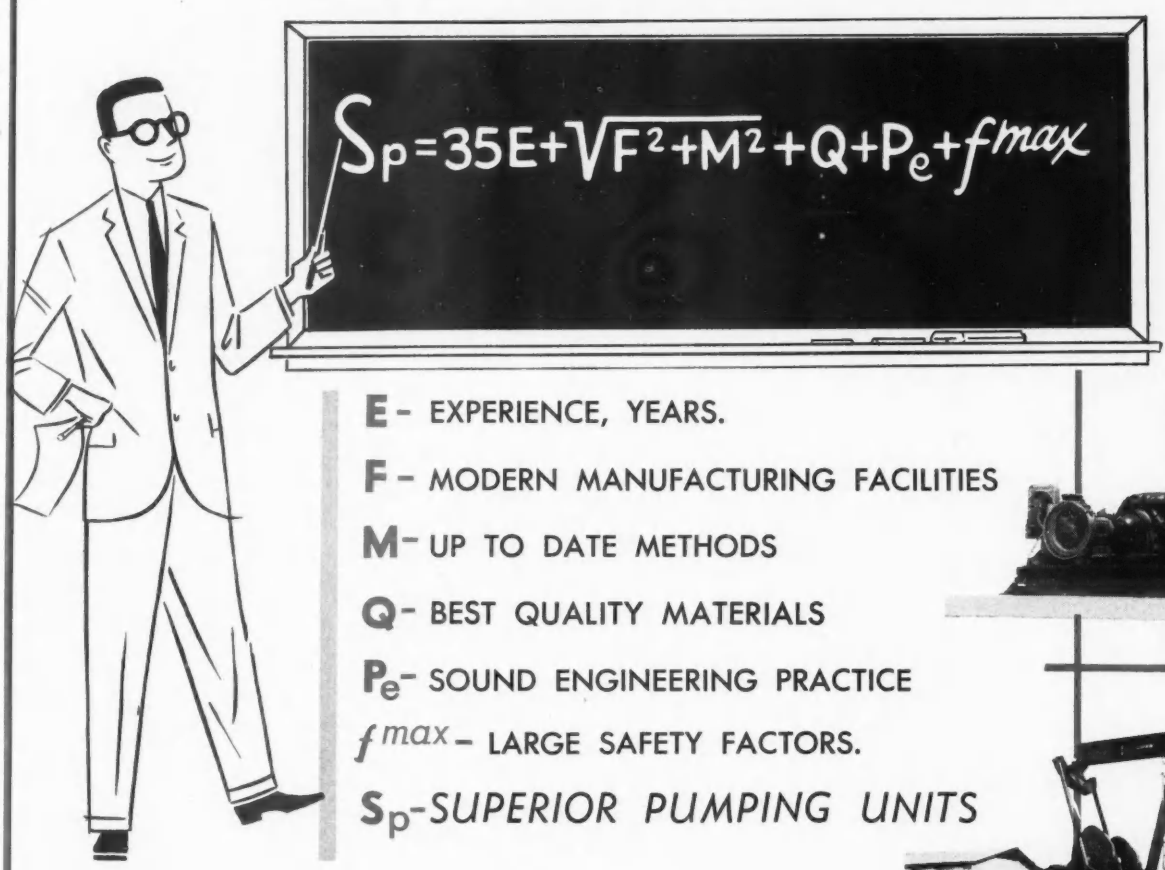

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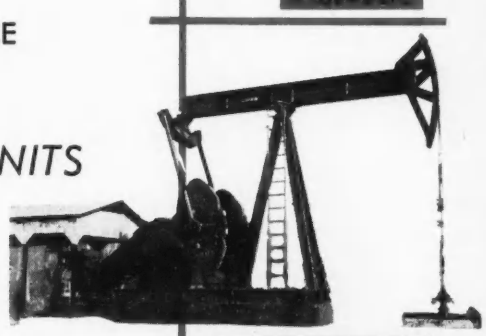
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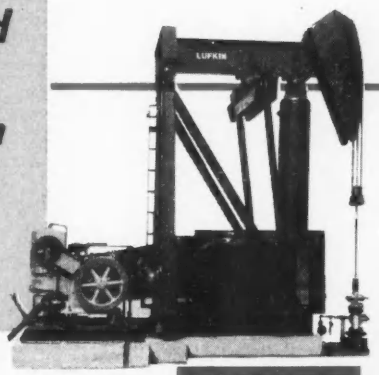
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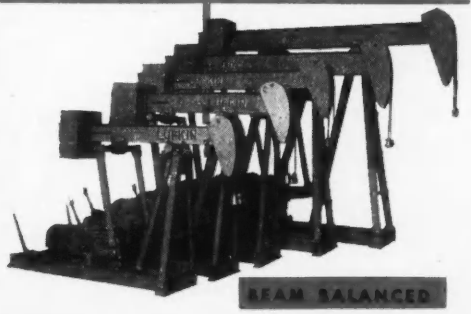
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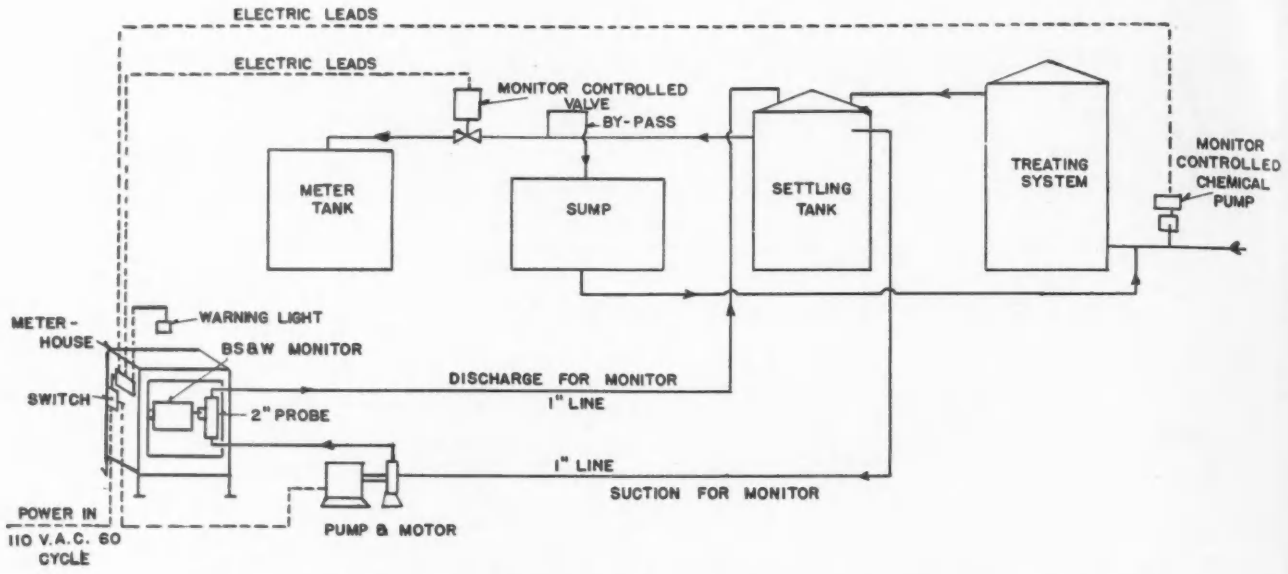

FIGURE 7—Schematic of BS&W monitor application in lease automatic custody transfer.

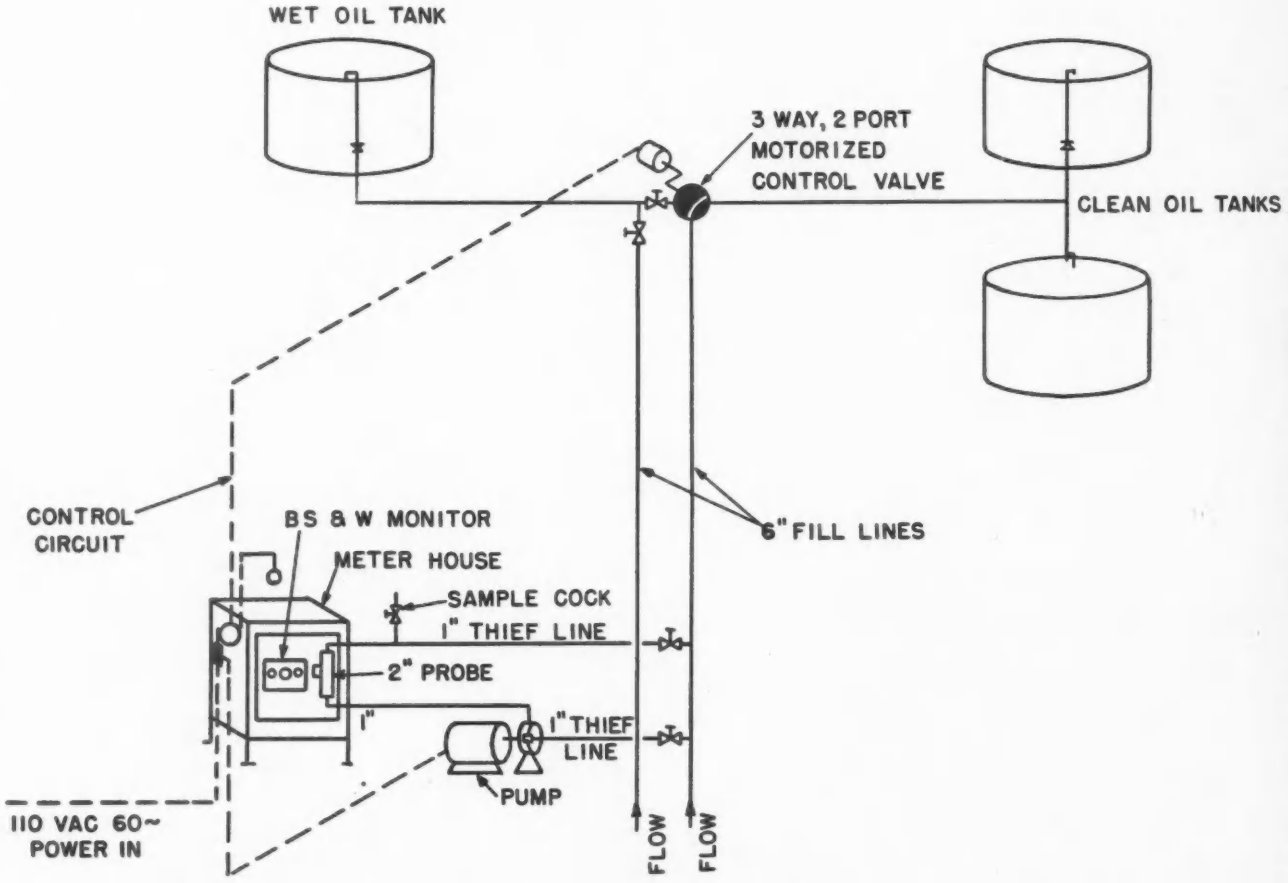

FIGURE 8—Schematic layout of BS&W monitor for control of clean oil at unattended discharge station.

every indication to date that the instrument will meet industry requirements. The device in its present form meets specifications for BS&W control in the API informational bulletin on automatic custody transfer. The monitor, developed and patented by Gulf Research & Development Company, will be available to the industry.

While developed primarily for BS&W control in automatic custody tank batteries, the monitor is adaptable to any process where changes in dielectric constant of fluids are suitable for control purposes. —**The End**

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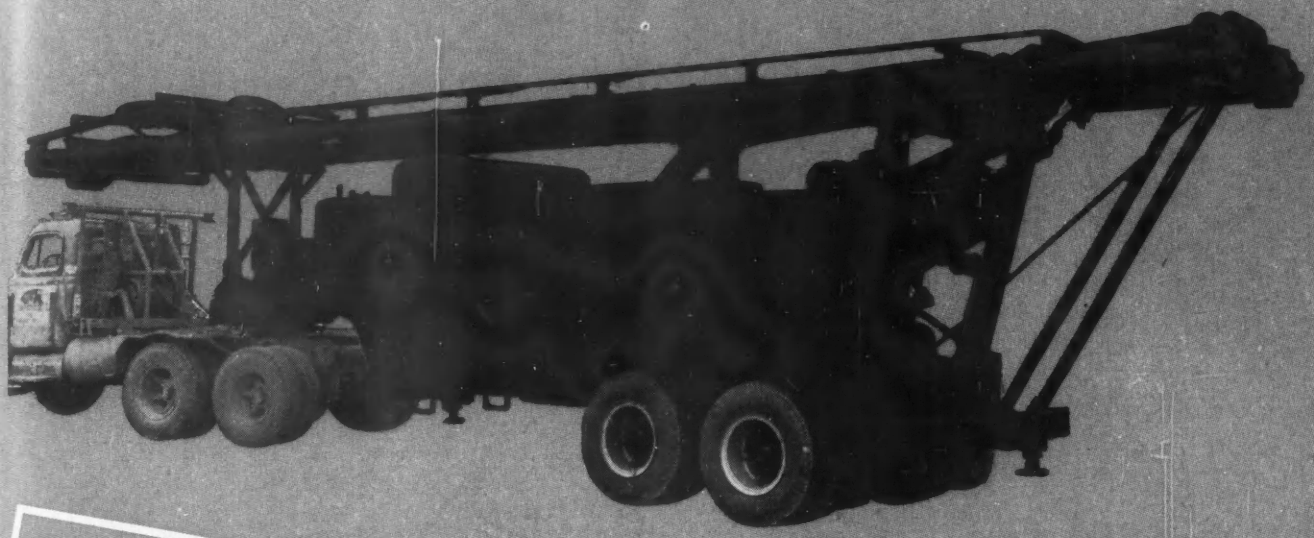

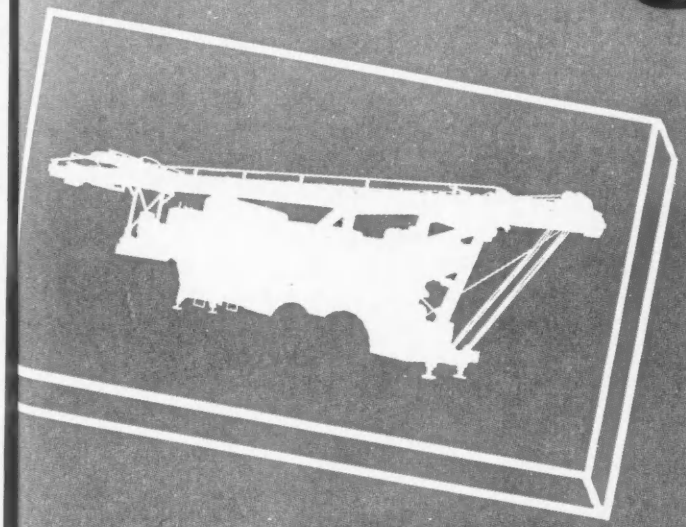

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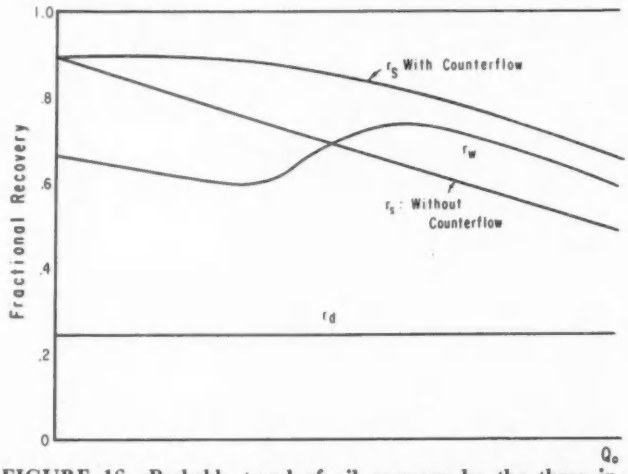

FIGURE 16—Probable trend of oil recovery by the three independent driving mechanisms as a function of field wide oil producing rate (Q_o).

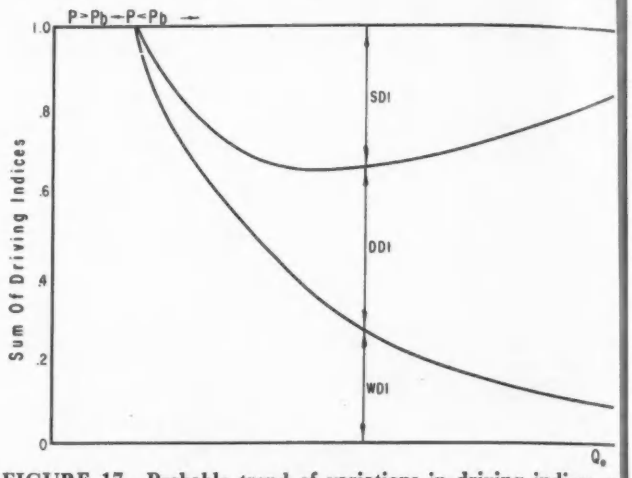

FIGURE 17—Probable trend of variations in driving indices as a function of field wide oil producing rate (Q_o).

Part 3—Combination Drive Fields, Unitization-Proration-Conservation

A Universal Theory of Oil Reservoir Engineering

Voluntary unitization and enlightened proration may contribute greatly to increased ultimate oil recovery, thereby promoting conservation.

By Dr. S. J. Pirson
The University of Texas, Austin

THE PRECEDING DISCUSSION has shown that field-wide oil recovery should be rate sensitive when frontal drive mechanisms are operative in recovering oil from reservoir rocks. Qualitatively, the recovery by each of the mechanisms may be represented as a function of field-wide production rate (Q_o) as shown in Figure 16.

Depletion drive is substantially a non-rate sensitive recovery process and its recovery value (r_d) is a constant regardless of the value of Q_o. There may be some conditions of rock texture, however, which may cause variations of r_d versus field-wide withdrawal rate such as complex pore structure, fracture porosity, differential depletion, etc. For this discussion r_d is assumed to remain constant with Q_o.

If a water drive is superimposed on the field, either occurring naturally by encroachment from an aquifer or artificially by water injection, water drive recovery (r_w) may remain fairly constant until such a rate of production is reached which permits field pressure to drop below the bubble point pressure of the oil. This is substantially so when the water drive is horizontal but for an up-dip water drive, recovery may be somewhat higher at very low withdrawal rates when field pressure remains above the bubble point. When field production rates are such that a free gas phase develops within the oil zone, the displacement efficiency of the water drive increases until an optimum field-wide production rate is reached and which may be determined analytically; thereafter at higher production rates, recovery by water drive decreases again.

If segregation drive is superimposed on a simple depletion performance, two situations are possible. Without counterflow of gas and oil, the recovery (r_s) decreases constantly with increasing withdrawal rates. If gas and oil counterflow is possible, while a high oil recovery is obtained at low field-wide production rates, somewhat higher oil recovery is possible at higher production rates until an optimum gas phase is developed in the oil column which permits the maximum rate of oil and gas counterflow. Thereafter, oil recovery efficiency by segregation with counterflow decreases.

In the general case where all three recovery processes are in operation simultaneously, and since each takes on relative degree of importance as measured by the driving indices (Figure 17) as a function of withdrawal rates, the overall oil ultimate recovery, which is the weighted average of the recoveries by the individual processes, is also a function of field withdrawal rate. In most cases it is a curve of the type shown in Figure 18. This curve indicates a maximum at a certain field production rate (Q_o) which may well be called the "Engineering MER" for the field. Since gross returns are proportional to the recovery curve, when subtracting operating cost per barrel recovered, a net return curve is obtained as a function of Q_o and it determines the "Economic MER."

Improved overall recoveries may also be secured at higher field production rates through the medium of gas injection and artificial water drive. It is obvious that in order to obtain the benefit of higher recovery through planned and engineered field-wide operations, it is necessary that the field be operated as a unit according to a

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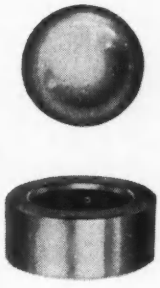

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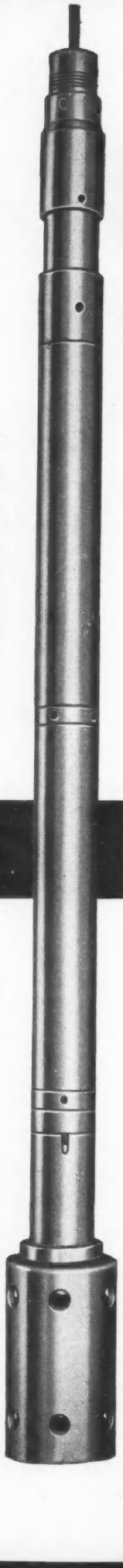

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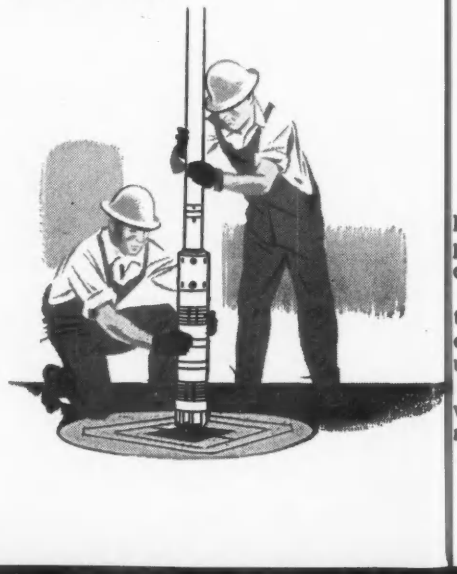

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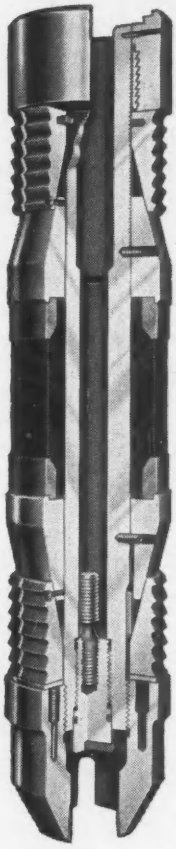

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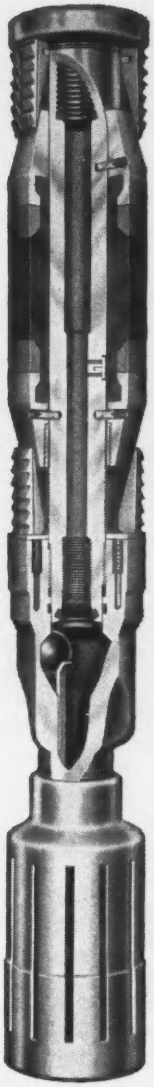

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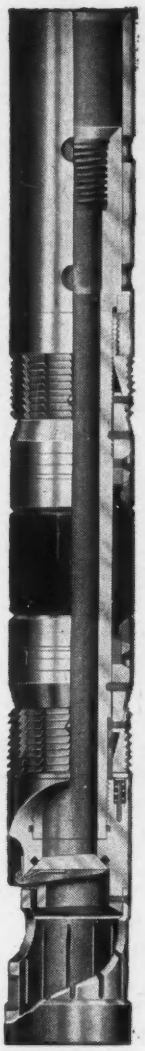

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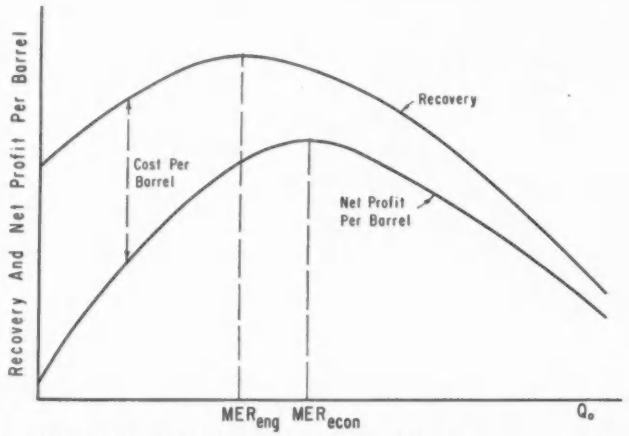

FIGURE 18—Probable trend of field wide oil recovery and of oil production cost as a function of field wide oil producing rate (Q_o).

master plan, the execution of which must be in experienced and authoritative hands.

Unitization. Unitization, or pooling of interest among the various owners of a field, is actually a technique of allocating in advance the returns from anticipated oil production issuing from a common source of supply, namely the geologic entity which constitutes the oil reservoir. Prior to 1930, allocation from a common source of supply was universally done by jungle practice, i.e., by the Rule of Capture. Such practice is still in effect in various states. Since that date official regulatory bodies in the main oil producing states have issued proration rules which allocate the state's oil market demand among the main producing fields. In many instances the allocation is made on a well basis.

Unitization of leases over a common reservoir and proration or allocation of market demand to the various pools go hand in hand.

In effect, unitization of oil and gas rights in an operation by which royalty owners and operators in a common reservoir exchange limited property rights for an equivalent undivided interest in a larger property, namely the unit. The original leases or royalties no longer exist.

The purposes for which unitization agreements are entered into are multiple and varied:

a. To reduce cost of production and of lease equipment, and to eliminate unnecessary wells without reducing ultimate recovery. This is generally the primary incentive.

b. To eliminate injurious competition among the operators and prevent a return to the application of the Rule of Capture.

c. To promote conservation of a natural resource and increase ultimate recovery through favoring the best recovery mechanism on a field-wide basis. This finds its best example of application when there is a large gas-cap through shutting-in of large gas-oil ratio wells.

d. To permit the application of external oil production stimulation means which achieve higher recovery such as by gas injection (in dispersed or in segregated manner) or by water injection (water flooding). This is a most important aspect of unitization and, in fact, it is the only reason that may be legally advanced in certain states to permit a pooling of interest and the elimination of competition. Unitization is a prerequisite to the field-wide application of stimulation or of secondary recovery techniques because through injection of gas or water, migration of oil across property lines takes place because of disturbances introduced thereby in the normal drainage pattern of wells under competitive production.

The crux of a unitization agreement is the determination of the participating interest fraction of all operators in the unit, i.e. the participation formula. In advance of the establishment of a unit, current production and gross income necessarily existed; the equity of each producer and royalty owner in the common supply is in fact his fair share of the current gross income derived from production under competitive methods. Gross income is specifically indicated because of possible differences in crude values. Factors which may enter into the determination of equity are:

1. Productive acreage.
2. Acre feet of effective reservoir; effective pay is, however, an interpretative element.
3. Recoverable oil-in-place exclusive of oil that may be recovered by migration from adjoining properties.
4. Producible reserves including oil that may be recovered by migration under normal competitive production practice. Recovery of oil by drainage of adjacent properties is difficult to evaluate objectively; it is mostly a matter of opinion.
5. Value of future reserves including those that may be obtained by stimulation and secondary recovery means. The question of overhead cost enters this factor and it is a variable with all operators.
6. Present worth of future earnings.
7. Current production or allowable. This is not a fair measure of reserves or of oil-in-place, but it is a measure of current income.
8. Cumulative production; this factor may be affected by migration and early development of a lease.
9. Number of wells; this is a measure of the investment on which return is expected.
10. Bottom-hole pressure; this may be a measure of the state of depletion of a property.
11. Well productivity; this factor is another measure of current income.
12. Ownership of oil-in-place; this is actually the net acre = feet $\times$ (oil/saturation). It is not a good element in a participation formula because it does not include oil that may be recovered by migration from other parts of the pool.
13. Acre-feet times porosity.
14. Acre-feet times permeability.
15. Present-day value of ultimate production or of reserves.
16. Adjusted acre-feet; this concept comes about in the unitization of two-phase reservoirs where it is necessary to establish relative values between oil and gas phases on an acre-foot basis. This requires that recovery factors for each zone be established and that a dollar value be agreed upon for oil, gas and condensate. In some units, gas-in-place has been given arbitrarily one-fifth the value of oil-in-place. In others, where gas is rich in distillate, gas and oil are given the same value per unit reservoir volume.

Reserves, migration and present worth are mostly a matter of interpretation, and it is difficult to arrive at irrefutable proof of evaluation; therefore they are a stum-

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bling block in unitization agreements and they are often left out of the mechanics of unitization proceedings whose primary purpose is to devise a participation formula by which the equity of each operator may readily be established.

The best participation formula is the simplest one that may be devised and that does not include interpretive elements; it should also assure equal treatment to all operators. A common formula determines participation in a unit on the basis of 50 percent on oil-in-place and 50 percent on current production. Oil-in-place is a measure of reserves whereas current production is a measure of earning power which are two factors of paramount importance in considering equity.

In a large field where oil will be moved over long distances across the reservoir (such as in the Sacroc Unit, Scurry County, Texas) more weight is given to reserves than to current production such as 75 percent on acre feet and 25 percent on production averaged over a stipulated base period. The Fullerton field formula is 50 percent on production and 50 percent on oil-in-place times bottom-hole pressure.

A participating formula which has been used in the Levelland field, West Texas, is 0.375 on acreage, 0.50 on current production, and 0.125 on the number of wells.

When depleted fields are unitized for the purpose of secondary recovery by water-flooding, past cumulative production often enters the formula as it is believed to be a measure of recoverable oil by artificial water drive.

While there are several types of units formed for special purposes such as spacing units for observance of spacing regulations, and exploration units for wildcat drilling and subsequent orderly field development, we are mainly concerned with producing units.

A recent development in designing participating formula is the split-formula. It was originally used in semi-depleted fields but now it is used in newly discovered flush fields. This formula recognizes that the share of oil production to which each owner is entitled is not necessarily the same during the period of primary production as during the period of stimulated or secondary recovery. The formula provides that, until a certain stipulated date or until a certain field-wide cumulative production has been obtained, the sharing of interest will be according to a certain pattern; beyond this point a different basis is used for the remainder of the life of the field. A basic principle in the establishment of a participating formula is the recognition that the allocation of production should be made equal to the contribution which each lease makes to the unit as a whole. It should also be cognizant of the production mechanism that prevails in the reservoir and of the degree of depletion that has already set in when unitization goes into effect.

Unitization regulations are variable in each oil producing state because one of the requirements before a producing unit may be formed is to ascertain that immunity from state anti-trust laws exists.

A number of oil producing states have definite unitization statutes:

Texas. The law is very specific in its requirements:

a. A unit agreement between operators is required before stimulation or secondary recovery operations may be applied to a reservoir.

b. The sole purpose for which unit operation is permitted is to prevent waste, promote conservation of all natural resources and protect the rights of all interested parties. A unit may not be formed to reduce operating cost and prevent competition; it must be shown that a real increase in oil recovery is to be obtained.

c. It must be shown that the increased cost of operation under unit agreement will be less than the value of additional oil recovered.

d. The area of the unit must be that defined by the drilling development; it may not be smaller or larger.

e. All interested parties must be given an equal opportunity to participate in the unit agreement. Participation must be on a voluntary basis.

f. Permission for unit operation is granted only after a public hearing before the state regulatory body: the Texas Railroad Commission.

Oklahoma. Unit operation may be formed only if at least 63 percent of the working interest approves as well as 63 percent of the royalty interest, exclusive of royalty interest held by lessee. Then minority interest is compelled to participate.

Arkansas. Unit operation is permitted only if at least 75 percent of all interested parties approve.

Louisiana. While voluntary oil and gas operating units are permitted, the state may compel the unitization of any recycling distillate fields on its own motion and assign participation in absence of agreement between interested parties.

In Colorado, New Mexico, Montana and Wyoming unitization of oil and gas pools is permitted for conservation purposes through the medium of selective production, while injection of gas or water is not always permitted.

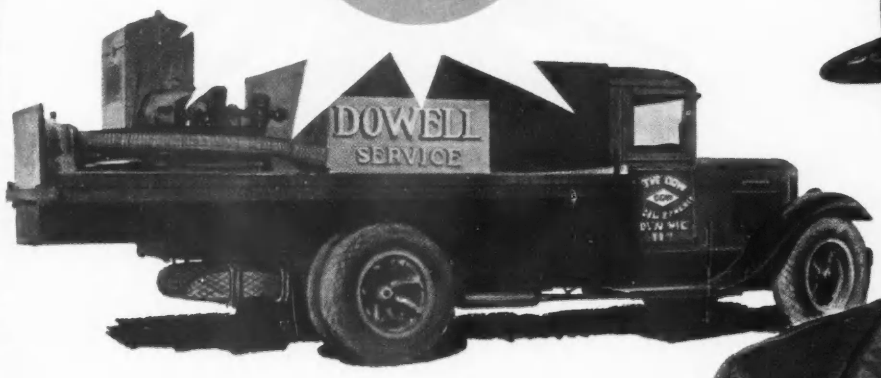
Ten other oil states have unitization statutes while California, Missouri, Utah and Virginia have no oil conservation laws whatsoever.

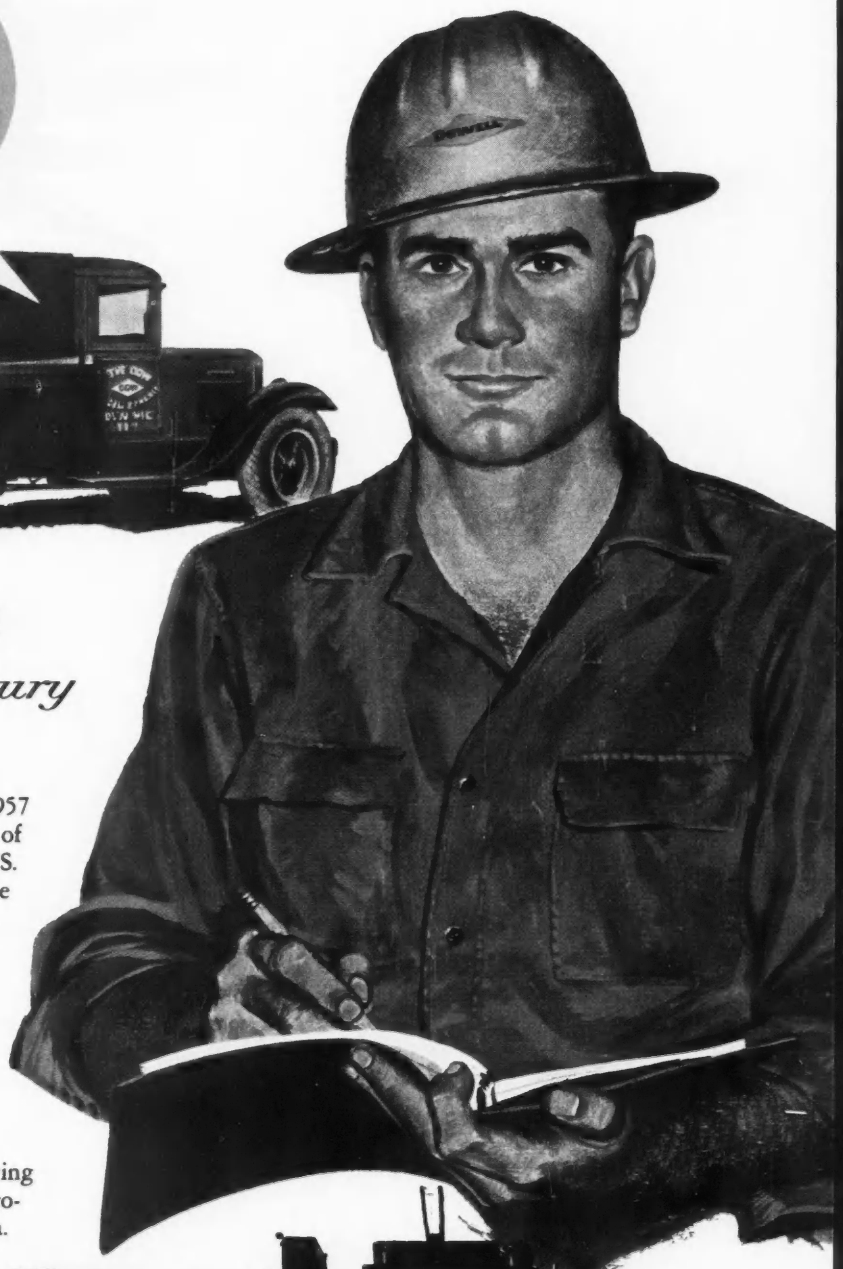
Proration and Conservation. It may be said that conservation of a wasting resource, and of oil in particular, is the intelligent and economic production of this resource with the minimum amount of waste as well as its intelligent and economic use. Unitization contributes to the elimination of physical waste underground, by promoting the efficient recovery of crude oil and gas condensate, as well as above ground by reducing gas flaring. However, waste of a depleting resource occurs also when it is produced at a rate greater than market demand. In this eventuality prices of the natural resource are depressed and marginal production must be abandoned; this is economic waste. It befalls the producing oil states to determine periodically the current market demand for crude oil, to recommend a national production ceiling and to allocate such production between the various states. The machinery through which this is accomplished is the Interstate Oil Compact Commission, which meets quarterly and has a permanent committee studying the supply and demand problems and makes recommendations for approval by oil state governors.

Within an oil state itself, the allocation of state quota among pools and wells is made through the medium of proration. The machinery of the state proration differs with each state:

In Texas an allowable per well is fixed generally at one barrel per day per acre drained, but the total monthly allowable is limited by controlling the number

25 *years forward*





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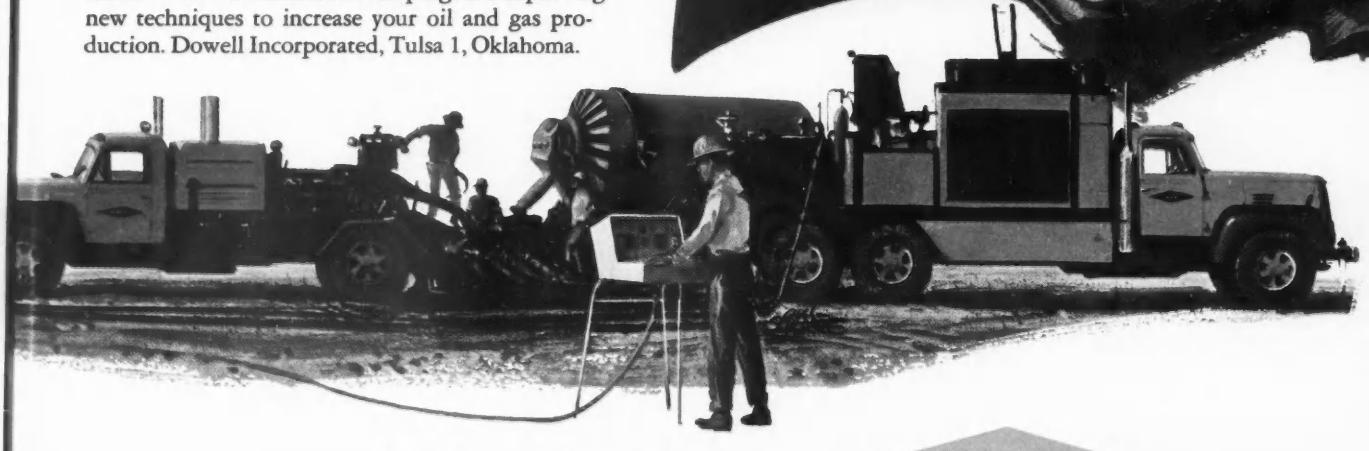

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For twenty-five years Dowell men have been going places. They have built the most advanced equipment, including the powerful Allison pumpers. They have developed and are constantly improving the industry's widest assortment of specialized well treating chemicals. They have perfected new and exciting techniques of fracturing, acidizing and cementing. These are important reasons why you have called Dowell. But there's still another: the twenty-five years' experience Dowell men have had throughout the U. S. and Canada. Experience built on doing the job right, doing it safely, doing it so you will continue to call Dowell.
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25 *years forward*

Services for the oil industry

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of monthly producing days. Stimulation and secondary recovery projects by water injection are not presently limited in production.

Allocation of state quota between fields is based on the determination of an MER for each field through the medium of yearly MER hearings conducted by the Texas Railroad Commission; at such meetings a serious effort is made to determine the proper MER for each pool in the state.

In Oklahoma production allowable per well is varied on a barrel per day basis according to state quota. Stimulation and secondary recovery projects by water injection are not limited in production.

When a new field is brought in, it is given a preference or discovery allowable of 150 bbl/day. This is to remain in effect for 60 days or for such period as may be required to properly test the well, after which time the operator requests from the Oklahoma Corporation Commission to be granted an allowable which in its judgment is a safe producing rate for the well and field. The Commission generally permits the requested rate unless it is unreasonably high. In effect, the MER in a field is set by the original discoverers in cooperation with later operators.

In Louisiana a depth schedule allowable method is used to determine field allowable. The greater the depth of production, the greater the allowable; this recognizes the need for return on investment, but not engineering merit, as a measure to increase recovery and promote conservation.

In New Mexico a technique of MER determination similar to that of Louisiana is in favor.

In Mississippi the MER of a pool is set by the Conservation Commission of that state based on recommendations from operators in that pool.

Proration is a state machinery which, in the main, prevents economic waste from flush fields. It treats them more or less equally on a well basis and pays little or no attention to the fact that oil fields, especially if they produce by the water or segregation drive mechanisms, should be operated at withdrawal rates specific to each in order to insure maximum recovery and prevent underground waste. State conservation authorities should be cognizant of this fact in order to promote real conservation of oil and gas resources.

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—**The End**

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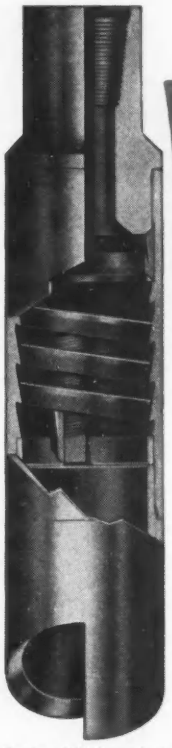

Series 150 Overshot Dressed with Spiral Grapple and Parts

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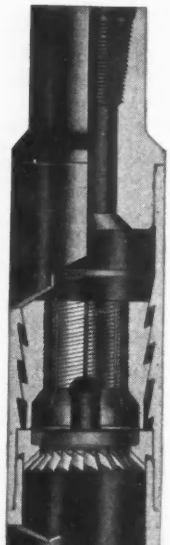

Series 150 Overshot Dressed with Basket Grapple and Parts

SERIES 150 (SINGLE BOWL) BOWEN Releasing and Circulating OVERSHOT

Series 150 (Single Bowl) Bowen Releasing and Circulating Overshots are compact units made up of a Top Sub, a Bowl, and a Guide. They can be dressed with standard parts to engage and pack off a specific maximum size or with undersize parts to engage and pack off any smaller sizes.

SIMPLE AND EASY TO DRESS If the OD of the fish is close to the maximum catch of the Overshot, only three parts are required to dress the Overshot to engage and pack it off—a Rubber, a Spiral Grapple, and a Grapple Control. The Rubber drops easily into place in the top of the Bowl.

If the OD of the fish is somewhat below the maximum catch of the Overshot, *only two parts* are required to dress the Overshot to engage and pack it off—a Basket Grapple and a Control Packer. If the top of the fish is apt to be burred or ragged, a Mill Control Packer is used in place of the Control Packer. The teeth will trim the fish and insure perfect performance of the replaceable rubber element and the Grapple. These parts assemble quickly and easily into the Bowl from its lower end. They cannot be assembled incorrectly.

Basket Grapples are a most efficient means for engaging external upset sections or couplings as they can be provided with a solid steel stop in their upper ends to insure location of the fish within their wickered areas.

SETTING AND RELEASING TO THE RIGHT PROVIDES UTMOST SAFETY

The Bowen Overshot both sets and releases TO THE RIGHT so that the fishing string is never turned in an unscrewing direction — a vital safety point.

Positive Grip: When the top of the fish is reached, only slow right hand rotation and simultaneous lowering is required to properly locate the fish within the Grapple and Rubber. Thereafter when the string is elevated, the Grapple grips firmly and evenly over a large area of the fish in much the same manner that the "Chinese handcuff" illustrated here- with tightens when pull is exerted. As pull is increased, the grapple tightens about the fish—the greater the pull, the tighter the grip—without danger of distorting the fish.

Positive Release: To release, merely bump down, then rotate slowly to the right and simultaneously elevate the fishing string until the overshot is off the fish. The right hand rotation will cause the grapple to expand and actually let go of the fish — the operator does not have to depend on the ability to unscrew from a fish.

SIMPLE ACCESSORIES PROVIDE GREAT VERSATILITY

EXTENSIONS: Installed between Top Sub and Bowl of Overshot to allow tool to be lowered over fish with unengageable upper end.

OVERSIZE GUIDES: To adapt overshot to insure alignment of tool with fish in large holes.

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Bowen Releasing and Circulating Overshots are also made in Multiple Bowl assemblies for two and three sizes of fish. *A Bowen Overshot that can engage and pack off the drilling string at any point of failure should be on every rig floor before drilling is undertaken.*

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Crude from the Barinas basin, a remote area in southwestern Venezuela and site of this drilling rig, was scheduled to begin moving to the Caribbean port of Puerto Cabello through the new $26 million, 212-mile pipe line. Socony Mobil Oil Company de Venezuela and Sinclair Oil and Refining Company own the pipe line, which may result in more vigorous exploration operations in this area.

Big-Inch Crude Pipe Line 'Frees' Barinas Basin Oil

Socony Mobil Oil Company de Venezuela and Sinclair Oil and Refining Company scheduled to begin operating new $26 million, 212-mile link from isolated Venezuela fields to Puerto Cabello. Nation's longest big-inch line may result in increased basin exploration.

By H. T. Brundage, World Oil Staff

SOCONY MOBILE OIL COMPANY de Venezuela and Sinclair Oil and Refining Company were scheduled to begin operating Venezuela's longest big-inch pipe line about November 1. This new $26 million, 212-mile, 20-inch crude line extends from San Silvestre station in the Barinas Basin of southwestern Venezuela to the Caribbean port of Puerto Cabello.

The pipe line represents the initial outlet for crude sources developed after more than 30 years of exploration and drilling operations in the nation's most isolated oil province. And even more vigorous exploration is anticipated as a result of the construction of this pipe line. This, in turn, may result in additional pipe line construction in the nation's interior.

Williams Brothers, of Tulsa, Okla., was the contractor for the project. Edwin Hubach, general manager for Williams Brothers in Venezuela, directed construction. Magnolia Petroleum Company, Socony's Southwest U.S. affiliate, engineered the line.

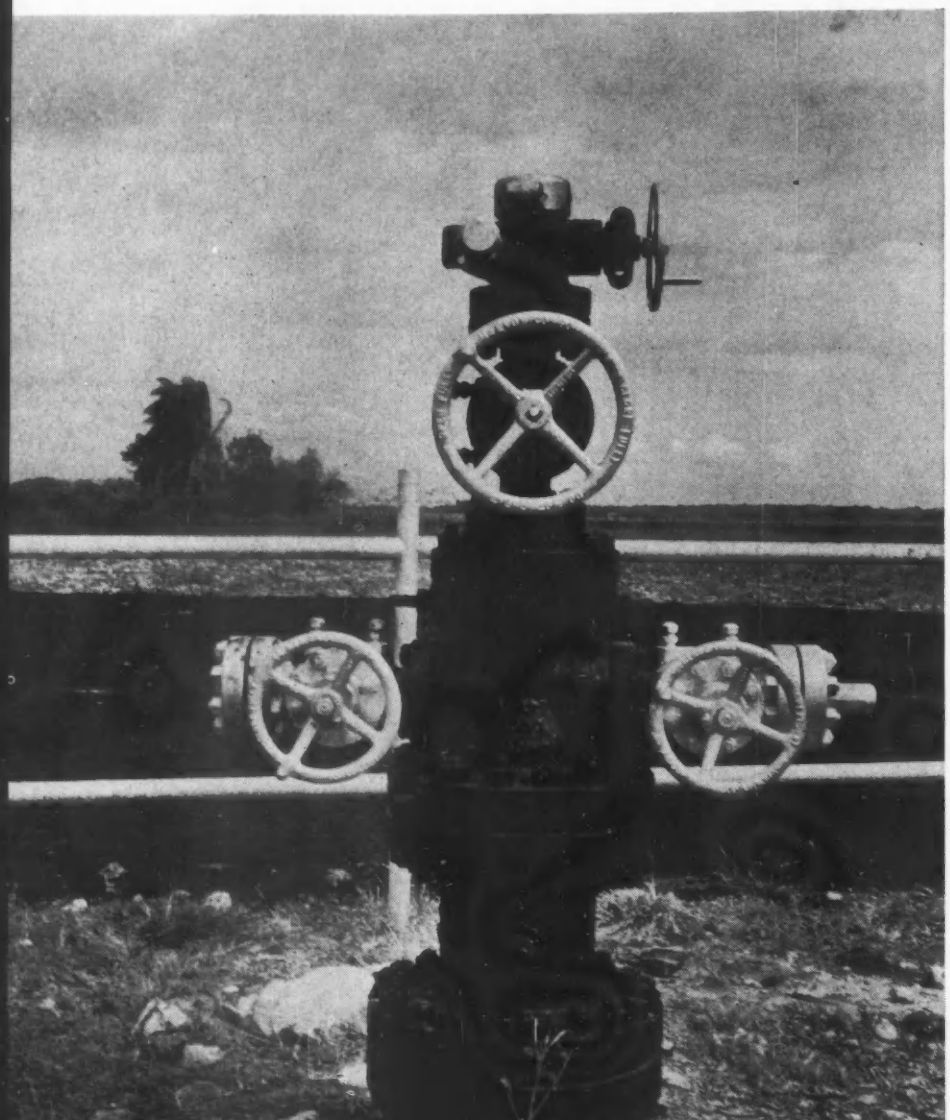
Construction Began in January. The first pipe was laid in January, with operations being expedited as much as possible to take advantage of the dry season, which occurs regularly in the area from about December to May. The remainder of the year is the season of heavy rains.

The last joint of pipe was laid June 20, except for several river crossings which since have been completed. The first welding was done January 8. During regular pipe laying operations, crews averaged 1.28 miles a day.

Conditions along the right-of-way included some thickly-wooded sections in the southern end, occasional rocky and hilly ground north of the mid-point and relatively flat terrain elsewhere. The pipe line route encountered mahogany trees larger than five feet in diameter at the base. These trees had to be removed individually, representing an unusual problem.

Methods. Bare pipe was placed about a foot above ground on concrete sleepers. Many streams and ravines were crossed with suspension spans and H-frames. Only in areas of other stream and road crossings—which totaled only about three miles along the right-of-way—was it necessary to bury the pipe and protect it from corrosion.

The 20-inch O.D. pipe consisted of both seamless and welded pipe. At river crossings, pipe with ½-inch wall thickness was used; pipe with wall thickness of ⅜-inch was used in the



This small Christmas tree is on a dually-completed well in Sinclair Oil and Refining Company's Sinco field, in Barinas, which is scheduled to go into production for the first time now that transportation facilities exist. Productive capacity from the Barinas area will be in the order of 50,000 barrels daily—from the Sinco field and from Socony Mobil Oil Company de Venezuela's Silvestre and Silvan fields.

first 35 miles downstream from the pump stations at Silvestre field; and over much of the remaining distance pipe with a wall thickness of 5/16-inch was laid.

Williams Brothers used two camps of portable aluminum buildings, one housing the crew while the second was set up at the next location.

Ownership. Socony has a 75 percent initial equity in the pipe line, with Sinclair holding the remaining interest. Sinclair will have the option of purchasing an additional 25 percent equity. Five years from the beginning of operations, the ownership ratio will become firm, whatever it may be at that time.

Capacity. The pipe line is designed for a capacity of 102,000 barrels daily and for an operating pressure of 1000 psi. It is conceivable that this capacity could be increased greatly if economic conditions warrant expansion.

Productive capacity in the Barinas area, when the line begins operating, will be in the order of 50,000 barrels a day. That, then, is the probable daily rate in the early months of operation.

At San Silvestre station, where four 150,000 barrel crude storage tanks were being completed, three centrifugal pumping units, each rated at 2080 hp at 1000 rpm, provide power to move the crude to El Palito terminal. The terminal is located 1¼ miles west of the city of Puerto Cabello on the Caribbean coast about 100 miles west of Caracas.

A second pump station may be built later at the approximate mid-point of the pipe line five miles south of Acarigua. However, it apparently will not be known immediately whether this station is to be built.

The three centrifugal pumping units at San Silvestre station are crude oil burning. Gravity of crude found in the three fields served by the pipe line — Socony's Silvestre and Silvan oil fields and Sinclair's Sinco field— ranges between about 21 and 30. The crude is asphalt base and will be mixed in storage and in the pipe line initially, though batching can be done later, if necessary.

Terminal Facilities. At the El Palito terminal, overlooking the harbor at an elevation of about 260 feet above sea level, storage capacity of 1,325,000 barrels was being readied. A causeway 1150 feet long, further extended by a 1200-foot pier, was built to provide berthing facilities for tankers which may load, one at a time, at the rate of 25,000 barrels an hour.

Crude is moved from the terminal storage tanks to tankers via gravity loading lines. Also planned are increased berthing facilities which will allow two tankers to load at Punta Chavez simultaneously at the rate of 25,000 barrels an hour. Water depth along the pier varies from 40 feet to 45 feet.

By late summer, Socony had made tentative plans to construct a refinery at Puerto Cabello to process Barinas crude. Socony now markets in Venezuela petroleum products which it buys from Sinclair.

Exploration. Sinclair's exploration in the Barinas Basin began more than 30 years ago, and exploration rights had been granted on more than 9 million acres in Apure and Barinas by the close of 1927.

Sinclair conducted geophysical surveys during the 1930's, and had for-

feited 7.5 million acres by the end of 1937. The first well drilled in the Barinas Basin was drilled to 5525 feet west of Barinas town and abandoned as dry.

Seismic work has been carried on almost continuously during the dry seasons since passage of the Law of Hydrocarbons in 1943.

By mid-1957, concession areas held in the Barinas-Apure Basin by nine companies totaled about 2.75 million acres. A large amount of prospective acreage still was held by the government and was expected to be included in future grants.

Sinclair first found oil in Barinas in May, 1953, upon completion of Sinco 1, located about three miles south of Socony's Silvestre 2 discovery well. Since then, Sinclair has drilled 38 wells at Sinco, of which 32 were oil producers, 3 were dry, and 3 were being completed at the end of August.

Socony's exploration in the Barinas Basin reached the drilling stage in 1943. After completing six dry holes, Socony opened Barinas to oil production with the completion of Silvestre 2, about 22 miles southeast of Barinas town.

In early 1957, Socony had completed 17 oil wells and expected to have at least 21 on production at Silvestre and Silvan when the new pipe line goes into operation.

Three producing sands at Silvestre, ranging in depth from 8500 feet to 9300 feet in Eocene and Cretaceous formations, have been proved up.

Socony's second field, Silvan, is only a few miles northwest of Silvestre field. There, the discovery well, Silvan 1, was followed by a northwest stepout, Silvan 2, which was a dry hole. Silvan 3 was being drilled during the summer to help further evaluate the field.

Field Comparison. Sinco and Silvestre fields appear to be similar, though it is indicated that Sinco may prove to be the greater producer.

Both fields have three oil sands. Sinco's depth range of pays is from 8000 feet to 9500 feet. The upper sand (Eocene) varies in thickness from 50 feet to 60 feet. Below that, the thickest—and most important sand (Cretaceous)—is 100 feet thick.

Still lower, a second Cretaceous oil sand is the least important of the three. The main sand is coarse-grained, clean, and poorly sorted, with generally good porosity. Oil saturation is high. Sinclair puts Sinco's estimated crude reserves at 66 million barrels, assuming there is no effective water drive, and at 172 million barrels if effective water drive exists. And test data indicate the presence of an effective water drive.

There is almost no gas, so it may be difficult to keep some of the wells flowing when the field enters full production status. Some flank wells already make water. However, they will be watched closely to determine whether there is effective water drive as production progresses. Some of these wells might be used later for pressure maintenance.

Another unusual feature of the Sinco field is that water produced in the wet wells is fresh or only slightly brackish. Producing sands, however, are believed to be marine in origin. These sandstones outcrop along the Andean front about 35 miles to the west.

On production tests of up to 20 days, no pressure drop has been noted, although wellhead pressures are only about 100-200 pounds and, therefore, are critical. Storage tanks at Sinco field are located on the lowest ground available so gravity can be utilized to the maximum extent in producing such low-pressure wells.

Since production is coming only after fairly thorough development has occurred, both Sinco and Silvestre field can be automated to a large extent as integrated units. At Sinco, there are three automatic gathering stations, with a gathering system of 6-, 8-, and 12-inch lines. Wells making water all are connected to the same station so the crude may be treated apart from water-free crude.

Wells going to water can be connected to the wet system to avoid contaminating crude directed into the other two stations. In wet wells, crude and water are emulsified somewhat, but the emulsion is breakable by a treating compound developed by Sinclair. This compound is found to be generally effective also in the treatment of emulsified Eastern Venezuela crudes.

Crude Movement. Initially, Sinclair proposes to move 30,000 barrels of crude daily to San Silvestre station, where the 20-inch pipe line begins. Sinclair's production is moved from Sinco field via a 4.75-mile, 16-inch above-ground pipe line. There are three pump stations on this line, each of which is equipped with three 25 hp reciprocating electric motor-driven pumps.

Drilling Programs. Sinclair is continuing drilling, with two rigs operating at Sinco. Exploration operations were scheduled to be resumed after the dry season starts in December.

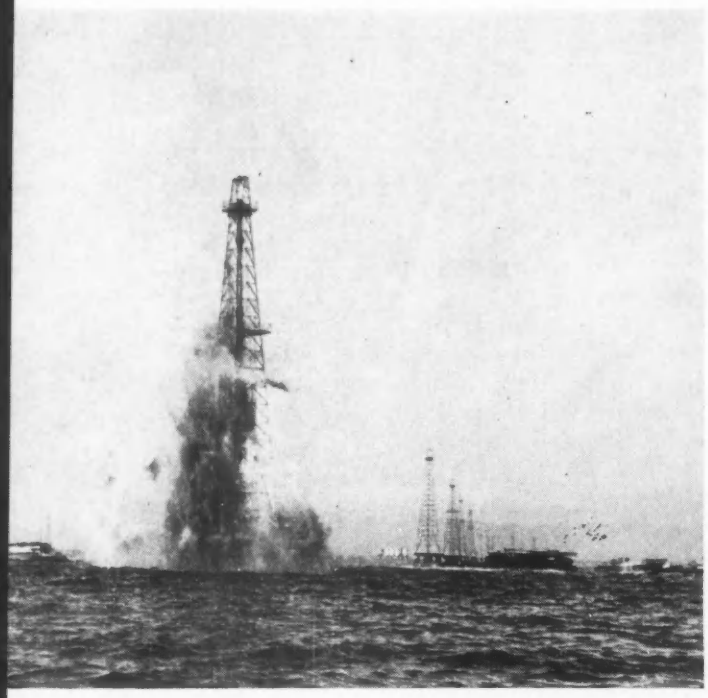
Socony maintained two contract rigs and one company rig during the past summer, with one at Silvan, one at Silvestre and the third on a wildcat test. A fourth rig was scheduled for exploratory work in the Barinas area.

Secondary Recovery. Socony already is experimenting with pressure maintenance in its Silvestre field. A pilot water injection program has been in operation since 1954. The mature development prior to production that both Silvestre and Sinco fields have undergone enables the operators to commence secondary recovery programs simultaneously with the start of large-scale production, in addition to the opportunity to automate production to a high degree.

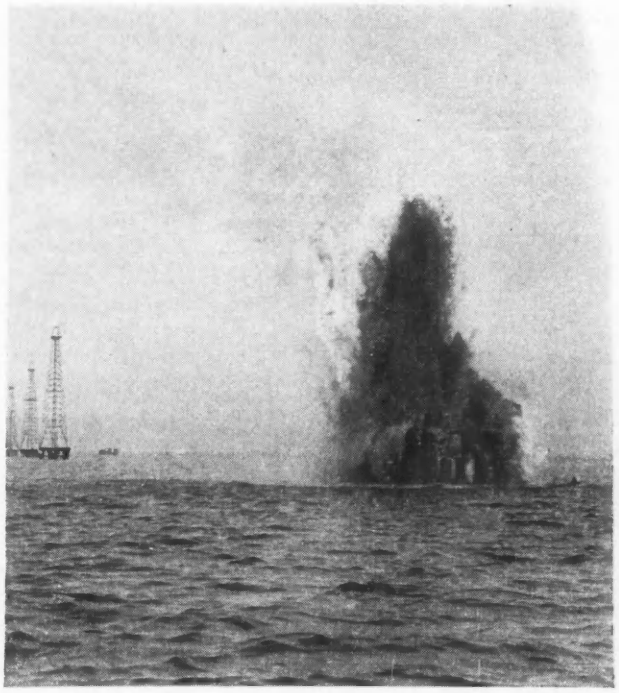
Future Development. Production data from Sinco and Silvestre will have a profound effect on Barinas Basin. If production holds up well and does not prove unduly expensive, exploration will be accelerated. If production does not prove as lucrative as hoped, potentialities of the large, virtually untouched area will continue to be speculative and exploration will not be as rapid as otherwise would be the case.

Both Silvestre and Sinco are anticlinal features, but there is considerable cross-faulting. At Sinco, however, the oil-water contacts are fairly constant throughout the field, indicating that the cross-faults generally are not sufficient in throw to interrupt the fluid levels from one fault block to another.

How this condition will affect water drive and/or possible future water injection in Sinco field is a question that currently looms as important to the future development of the Barinas-Apure Basin. —**The End**



FIRST DAY: Launches tow workover barge away from Well 20 within minutes after the well ignited on June 19.



SECOND DAY: The derrick fell during the night, and left a mass of steel on the well platform.

In Venezuela's Lake Maracaibo . . .

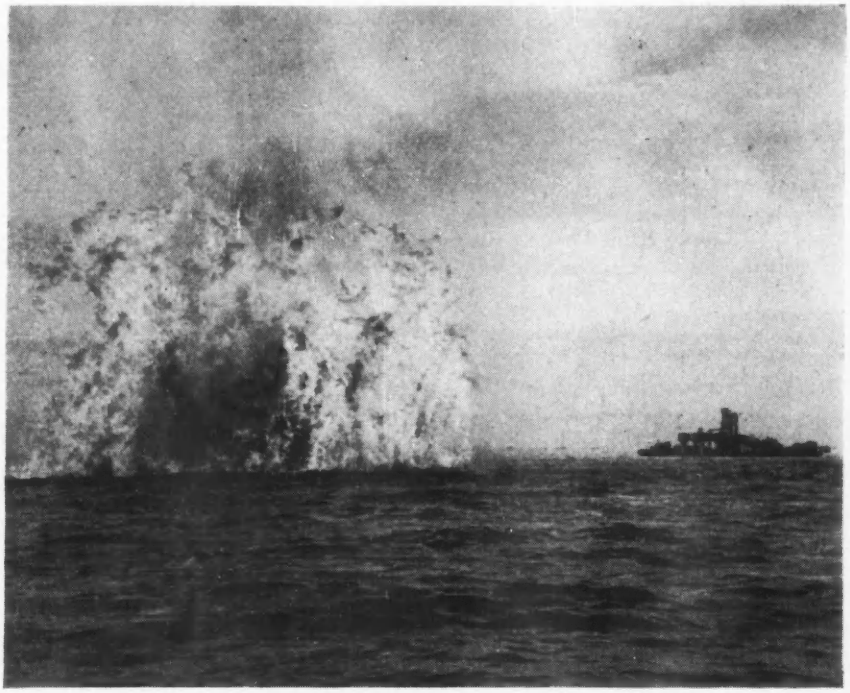
Photographs Capture Fury of Blazing Well

After 131 hours and 43 minutes, fire dies a natural death when well craters.

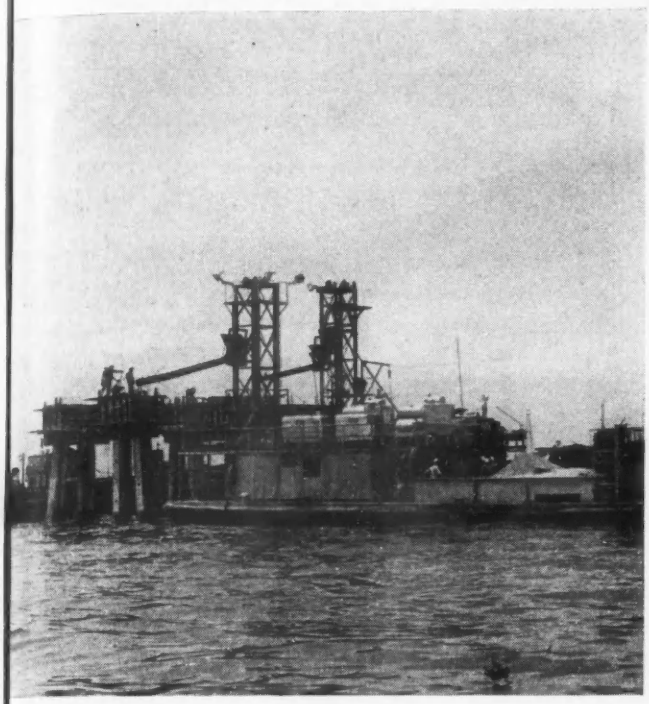
IN THE EARLY MORNING hours of June 19, Creole Petroleum Corporation's Well 20, located in Lake Maracaibo, blew out of control during workover operations. Immediate efforts to control it failed. At 5:17 p.m. a ball of flame suddenly enveloped the upper part of the derrick. A fraction of a second later, it traveled down to the platform.

Creole Petroleum prepared to drill an offset well through which it expected to control the wild well. However, the blazing well cratered, and died a natural death at 5 a.m. June 25 after 131 hours and 43 minutes.

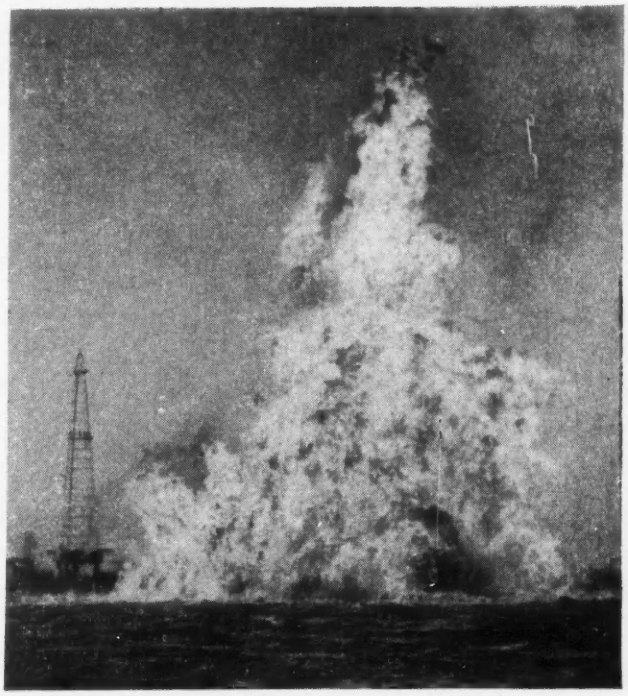
This is a picture story of that fire.



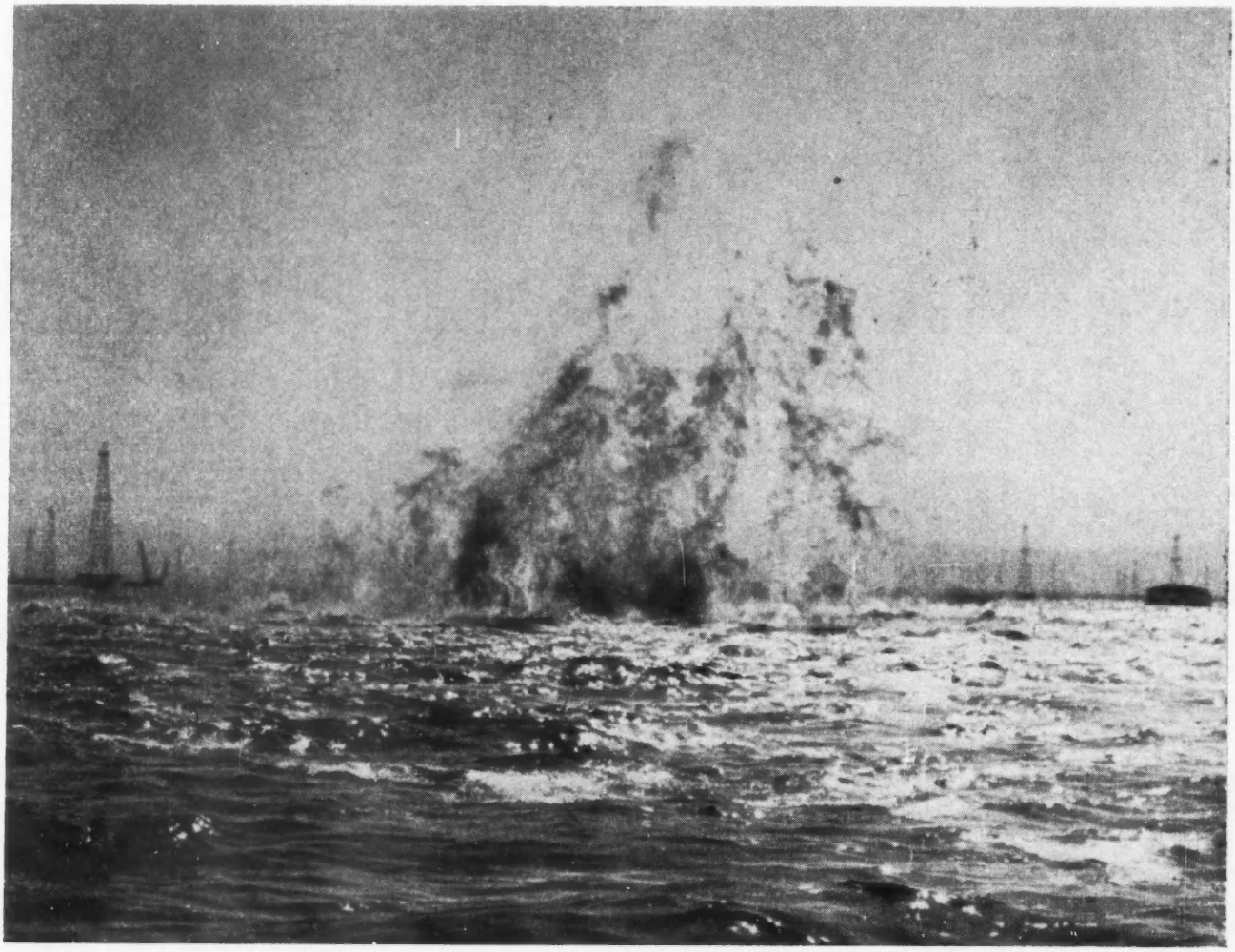
THIRD DAY: Flames continue to burn on the surface of Lake Maracaibo, due probably to gas and oil bubbling through the water. In the background, Creole had gotten under way with work on the substructure of the offset well.



THIRD DAY: This close-up photo of the preparations for the company's offset well shows concrete piles being capped for the derrick.



FOURTH DAY: While gas and oil bubbled through the lake surface creating small waves and a bright flame, the derrick for the offset well (background) was placed on piles.



DEATH OF A DERRICK: About sunset of the fourth day, flames had weakened. Where a derrick had been, there was nothing.

These residences are examples of Creole Petroleum Corporation employe housing in the Judibana Development near Amuay, Venezuela.

Creole Undertaking Community Integration

Steps are underway in Venezuela to replace the old paternalistic oil field camp by development of neighboring communities with privately-owned homes, stores, public schools and hospitals.

By Warren L. Baker, Editorial Director, WORLD OIL

AN IMPORTANT new development with respect to oil field camps has been inaugurated by Creole Petroleum Corporation in Venezuela. The old concept of the traditional closed camp for employes has been replaced with a new plan which calls for the eventual integration of all company employes into communities that have developed around them. In areas where no such communities have developed, steps are being taken to encourage their growth so that they can take the place of camps.

The new plan is designated as the "Community Integration and Development" program. Community integration is not an objective that can be reached quickly, or all at one time. The difficulties are many and some of them are serious. The goal admittedly is a long-range one and will take many years to accomplish.

Creole's management is convinced

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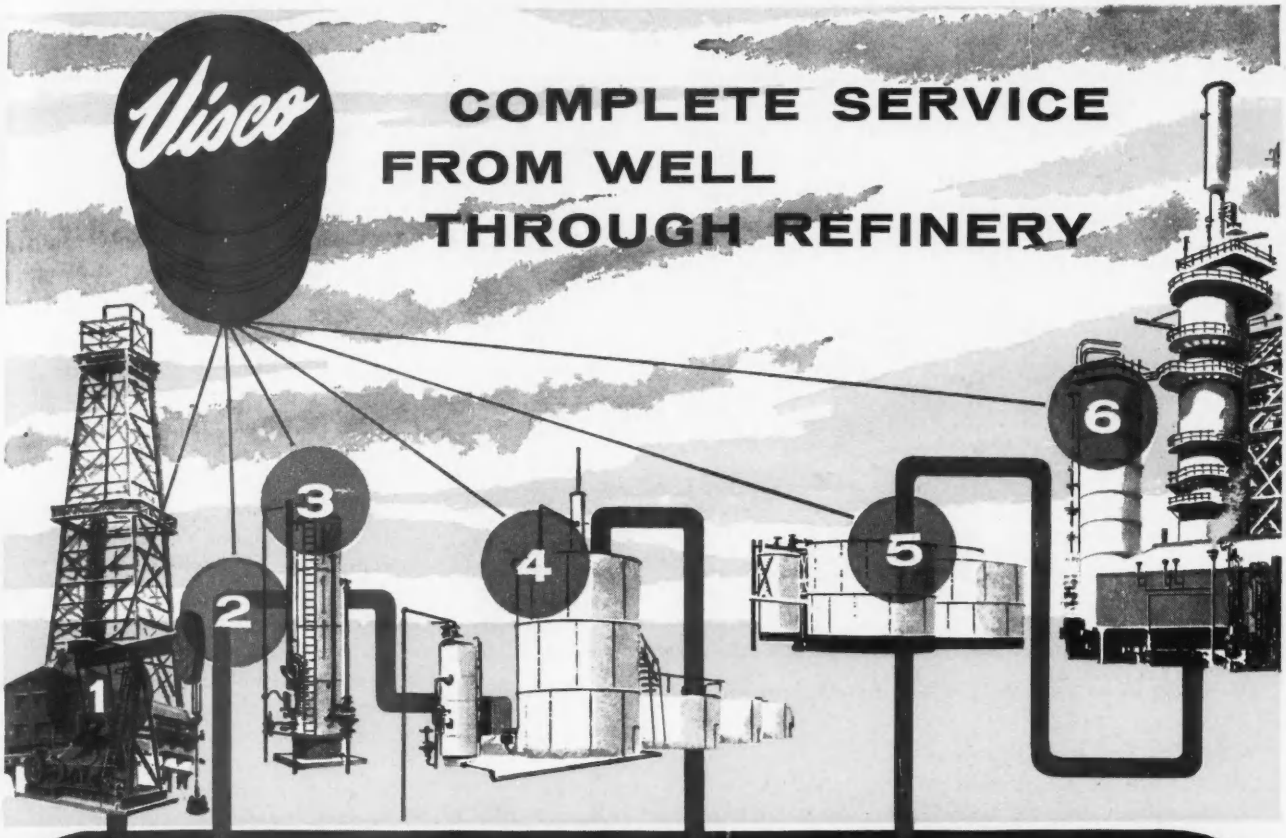

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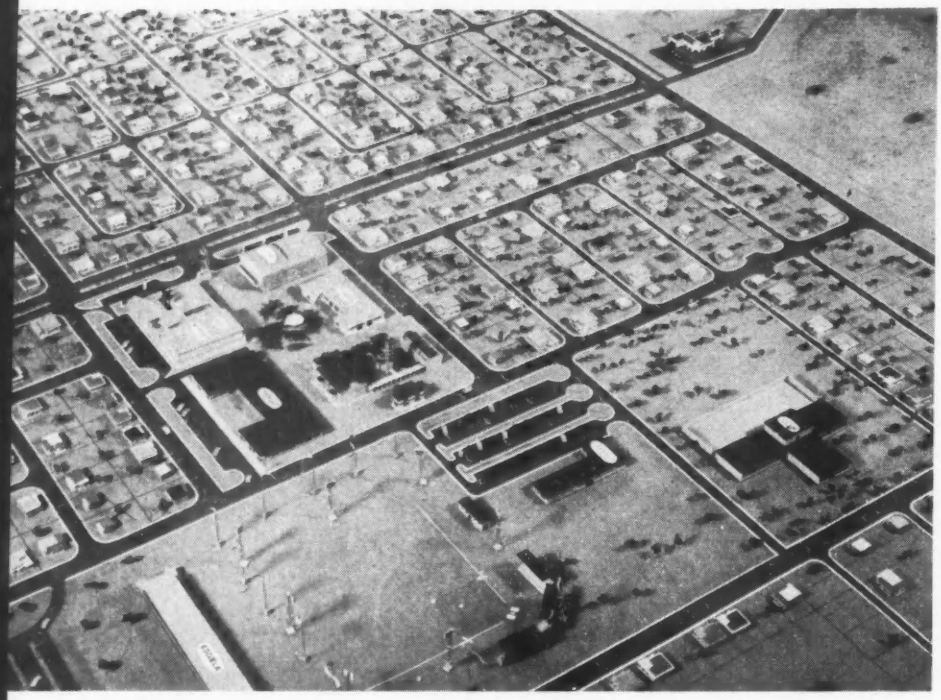


This model shows what the Judibana Development will look like in the future.

that the old practice of oil field camp society, in which the company furnished all the needs of its employes, must give way. It believes this is in the interest of a sound development of economic and social life in the growing oil communities of Venezuela, and also in the interest of relieving the company of many responsibilities that are not really a part of the oil business.

Creole officials believe the continuation of the old paternalistic pattern would be detrimental to the employe, the community and the nation, at the same time serving no useful company aim. This thinking is based on the world's experience that social progress is accelerated by the encouragement of individual initiative and by the application of community government.

Housing Is the Key in the community integration problem. The program is making it possible for Creole employes to own their own homes, and features homes individually selected by the worker and built to his order.

The company has developed a liberal loan plan to aid employes in building their own homes. These developments are being undertaken on the same basis as if they were in the U. S., with private contractors building and selling the homes to all who wish to buy.

Another major step toward community integration has been to put its housing for higher salaried staff employes on a rental basis. Staff employes now are required to pay "realistic" monthly rent, and also bear the cost of their utilities. Staff salaries were raised to offset the increased cash outlay. But now the employe does not need to stay in the camp if he prefers to live outside. The company's responsibilities now are no more than that of a normal landlord, whereas it used to extend to repairing furniture and replacing light bulbs.

Other community services must necessarily be fitted into Creole's integration program. The company realizes it cannot simply stop providing a service, and that an equally attractive substitute must be available. Here, again, the company policy of community integration has been at work.

The $6 million Maracaibo hospital has been leased to the Medical Mission Sisters. Direction of the hospital is entirely in the hands of the missionary nuns, who run it just as any other hospital might be run. Except for Creole's prior claim on 60 beds, the 165-bed hospital is open to the public and qualified private doctors.

Creole also is getting out of the education field. Its school at Amuay has been leased to the Salesian religious order. Of the 800 pupils, 150 come from non-Creole families. Creole pays full tuition for the children of its employes.

After making substantial donations toward adequate facilities in nearby communities, Creole has been able to close down three of its own high schools.

Creole has arranged for privately-owned supermarkets near two of its camps. These supermarkets are open to the public, while company camp commissaries were not.

Outside community relations are another difficult problem in Creole's integration program. The outside community often is larger than the camp. Housing is difficult to find. Water and sewer systems are totally inadequate, causing sub-normal health conditions.

Furthermore, there is little local responsibility for handling such problems. This lack makes it difficult to turn over community functions. Consequently, Creole is following a policy of first supporting the fringe communities in their efforts to get public authorities to undertake public improvement, next of joining public authorities in financing public projects, and finally of doing what needs to be done itself if there is no other way.

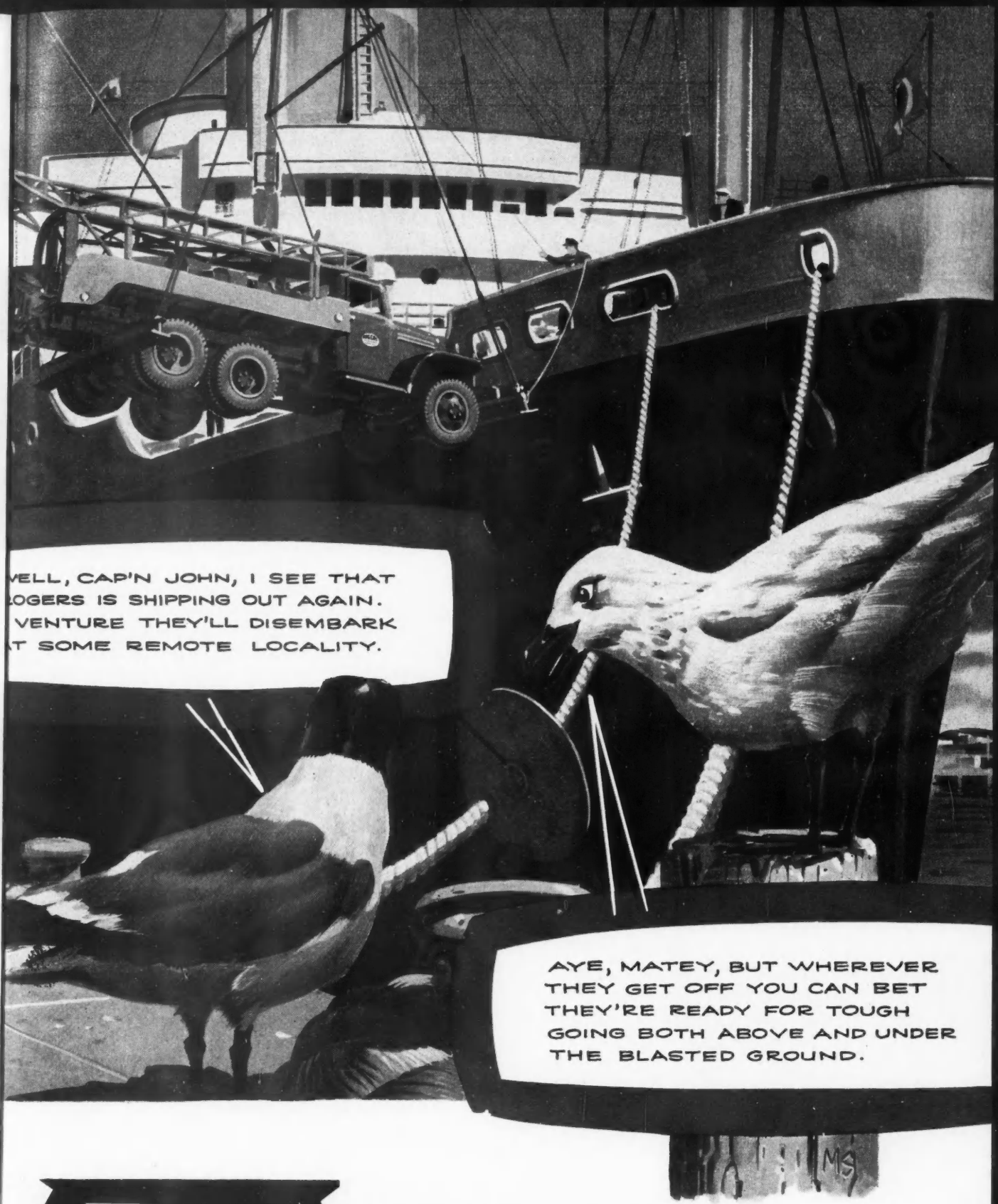
For many reasons Creole's community integration system cannot be expected to move swiftly toward its ultimate goal. Slow progress, however, is seen by Creole officials as being better than no progress at all.—**The End**

Hunt Interests' Third Test In Pakistan Is Abandoned

The Hunt Interests of Dallas abandoned their third test well in Pakistan by plugging a 10,166-foot hole near Sari Sing after tests showed the area unproductive. Their two previous test wells drilled on the Dhak structure, 100 air miles west of Karachi on the Mekran coast, also were dry.

Drilling equipment was being moved 45 road miles northeast of Sari Sing to the Sunbak structure, where Sunbak 1 will be drilled. The Sunbak structure is eight miles northeast of Thana Bula Khan.

The Hunts' geological, gravity and seismograph parties, which have been conducting extensive studies in the southern half of Dadu district during the past eight months, have moved into Thatta district.


VELL, CAP'N JOHN, I SEE THAT
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AYE, MATEY, BUT WHEREVER THEY GET OFF YOU CAN BET THEY'RE READY FOR TOUGH GOING BOTH ABOVE AND UNDER THE BLASTED GROUND.

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Mr. Vaught says:

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This is our third CARDWELL rig, and, due to the fact that repair and replacement have been practically nil on the other two, I have every confidence in the L-350 with its new free-standing mast as a lightweight, high capacity draw works."

**The unit purchased by A. B. Vaught, Midland, Texas, is a twin-engine, single-drum L-350 with rotary drive and a 15" double rotor hydromatic brake package, in combination with Cardwell's new 96' free-standing mast.*

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CHAIN DRIVES—with positive oil bath lubrication, assure long life. Optional oil bath lubrication available for Rotary Table Drive.

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two full ranges of line speeds and pulls . . .
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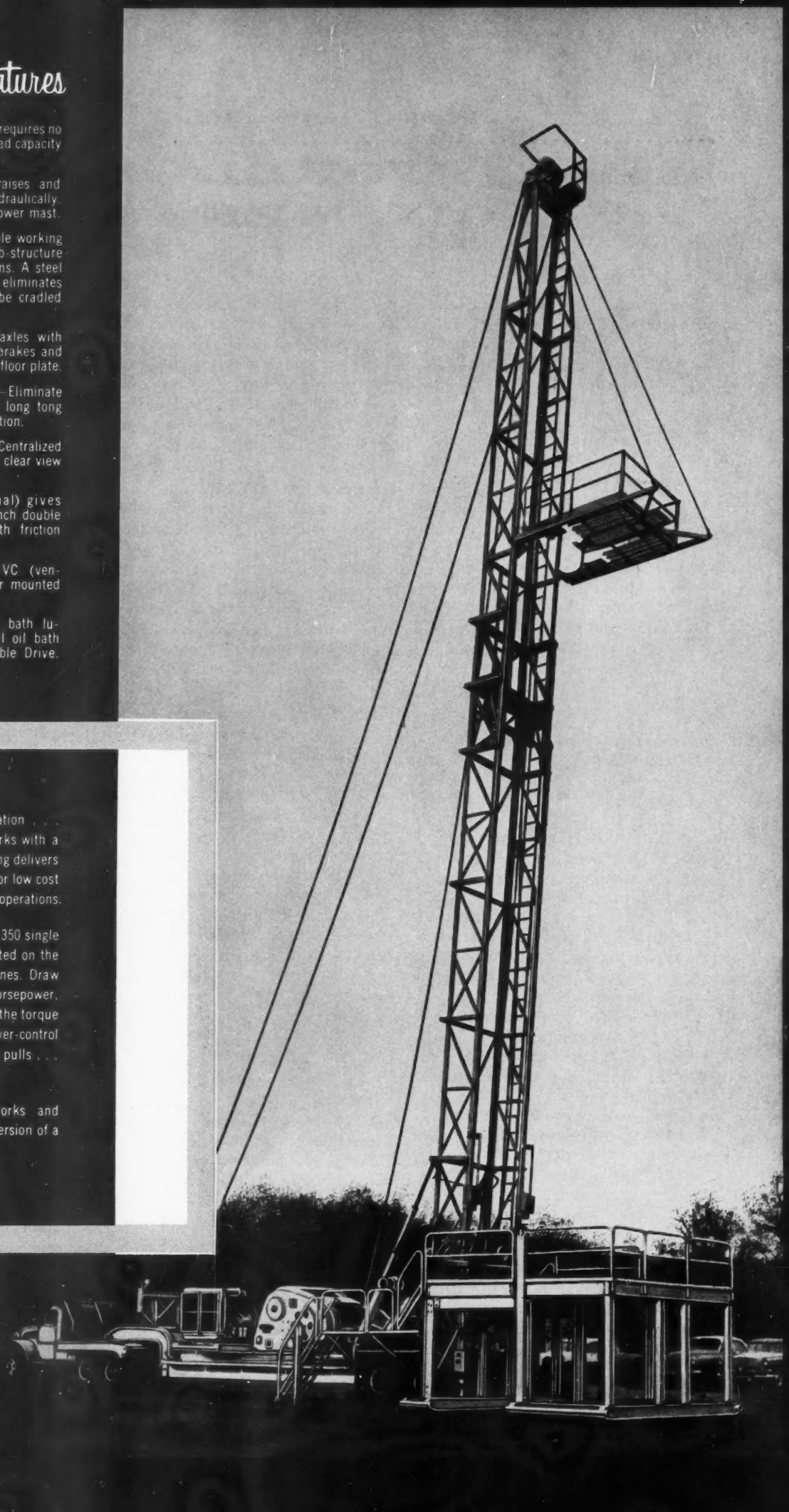

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What's Happening

among WORLD OIL MEN

WERNER F. SCHNEEBERGER, manager of foreign exploration for Ball Associates, Oil and Gas Consultants of Washington, D. C., and Denver, Colo., has been nominated consultant by Timor Oil Ltd. for its operations in Portuguese Timor and Gulf Oil Syndicate for its operations in western Australia.

W. F. Schneeberger

Schneeberger also will spend some time on consuting work in the Republic of Indonesia.

•

GRAHAM F. TOWERS has been named chairman of British Petroleum (Canada) Ltd.

•

A. B. BROWN was elected president of Richmond Exploration Company, succeeding C. R. CABRERA, who recently was appointed to Standard Oil Company of California's executive staff. Richmond is a South American producing and exploration subsidiary of Standard of California and operates in Venezuela.

Brown joined Standard in 1930 as a geologist in Ventura, Calif. He then held posts in western U. S., Saudi Arabia, Texas, Sumatra, Louisiana, Venezuela, Peru and Colombia. For the past two years, he has been in Indonesia, where he served as managing director of Standard's affiliate, Caltex Pacific Petroleum Company. Brown's headquarters will be in Caracas.

•

WILLIAM W. CLAWSON, president of Mobil Producing Company and Mobil Oil of Canada, Ltd., has been named coordinator of domestic production and a member of the producing committee of the parent company, Socony Mobil Oil Company. Replacing him as president in the two posts at Mobil Producing headquarters in Billings, Mont., will be EDWARD C. CRAM, presently coordinator of domestic production.

Clawson, who has directed the activities of the two exploration and producing affiliates since 1952, joined Socony Mobil in 1933 as a geologist for its Southwest affiliate, Magnolia Petroleum Company. He was chief geologist of Magnolia from 1946 to 1952. A graduate of the University of Kansas, he was last year awarded an honorary doctorate of engineering by the Montana School of Mines.

Cram, who has been coordinator of domestic production since 1953, joined the company as a geologist in 1936. In his early years with Socony Mobil he worked both in Venezuela and Colombia. From 1941 to 1951, he served as a geologist for Magnolia, the last five years as coordinator of exploitation in the headquarters office, Dallas. He went to Socony Mobil's headquarters in New York in 1951 where he was assistant coordinator of domestic production prior to being named to his present post. He is a graduate of Washington State College.

•

With operations expanding, SINCLAIR OIL AND REFINING COMPANY, subsidiary of Venezuelan Petroleum Company, is increasing its executive staff in Caracas. E. T. LINCOLN has been named executive assistant, a newly created post, and will transfer from Santa Barbara, Monagas, where he formerly served as general superintendent. W. C. SUMMY, former production superintendent, becomes general district superintendent in charge of drilling and production at Santa Barbara.

CARMEN R. APT is promoted to assistant Santa Barbara district superintendent, having been chief engineer there in charge of the gas and gas products plant. H. I. LIECHTY, formerly assistant to Apt, is named chief engineer. VALENTINE E. BURNETT, electrician at the gas products plant, has been transferred to Barinas as district electrician and supervisor, garage and transportation.

•

The Texas Company has made the following personnel changes. M. N. BROUGHTON has been appointed staff geologist in the New York office of Texaco's Foreign Operations department (Western Hemisphere and West Africa). Broughton has been staff geologist of Texaco's Domestic Producing department since 1954.

A native of South Carolina and a graduate of The University of Texas, Broughton joined Texaco in 1933 in the Paleontological laboratory in Houston. He worked in the Louisiana and South Texas divisions of the Producing department, advancing to the position of division geologist in the latter division in 1952. He served in that position two years before being transferred to New York as staff geologist of the Domestic Producing department.

J. R. CARROLL has been appointed assistant manager with offices at Caracas, Venezuela, of the Producing division of Texaco's Foreign Operations department (Western Hemisphere and West Africa). He formerly was manager of the Texas Petroleum Company's Venezuelan Producing division, at Caracas.

R. E. WRIGHT has succeeded Carroll as manager of Texpet's Venezuelan Producing division. Wright formerly was senior assistant manager.

Other appointments in Texpet's Venezuelan Producing division are:

PAUL YOUNGMEYER, formerly an assistant manager at Calgary, Canada, of Texaco Exploration Company, to assistant manager (exploration).

J. M. PATTERSON, from chief geologist to assistant to the manager. J. E. F. CASTON, to chief geologist and HARVEY STEIN to assistant chief geologist.

Here's where offshore drilling cut its teeth 47 years ago

The first successful overwater drilling in the United States was on Caddo Lake near Mooringsport, La., 1910.

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AFRICA: Some international groups are interested in the oil possibilities of Rio de Oro, southwest of Morocco on the Atlantic Coast. Any oil found would be located in coastal basin areas, convenient for export, and would have the additional advantage of proximity to Compañía Espanola de Petroleos' Tenerife refinery in the Canary Islands. Stumbling block is Spanish law, which does not permit granting of concession areas to non-Spanish firms.

ALGERIA: Five companies, two of them U. S., have formed a consortium to apply for exploration permits in the Algerian Sahara desert. Sinclair Petroleum Company, subsidiary of Sinclair Oil Corporation, and Newmont Mining Corporation together represent 45 percent interest in the group. The remaining interest is held by three French companies, Societe Francaise de Recherches et D'Exploitation du Petrole; Messrs. Lazard Freres et Cie., French banking firm; and l'Omnium de Valeurs Agricoles Industrielles et Minieres, French investment firm. Applications for several Sahara-area tracts have been filed by the group.

ARGENTINA: Yacimientos Fiscales Petroliferos, government oil agency, reportedly has awarded a contract for construction of a 280-mile, 12¾-inch crude oil pipe line from Pichanal to Tucuman, to Techint, S. A.

AUSTRIA: Important extensions were reported being made to the major field, Matzen-Auersthal. Austrian Mineral Oil Administration Spannberg 3 was drilled 2½ miles north of previous production to a total depth of 8023 feet, perforated from 7041-57 feet in the Helvetian, and brought in flowing up to 140 barrels of crude oil daily. Several stepouts from Spannberg 3 were being drilled in attempts to extend the field further.

BAFFIN ISLAND: An independent minerals exploration group was reported to have left Cleveland, Ohio, on a former sub-chaser with a helicopter on deck, to survey Baffin Island and other arctic areas for oil, iron and uranium. Leading the three-year exploratory effort were Cyrus S. Eaton interests, of Cleveland, List Industries Corporation of New York, and Scurry-Rainbow Oil Ltd. of Calgary, Canada.

CANADA: Interprovincial Pipe Line Company has announced completion of a 156-mile extension to its crude oil pipe line system to transport Alberta, Saskatchewan, and Manitoba crude to Eastern markets, with the network now totaling 1931 miles in length. The new 20-inch extension from Sarnia to Port Credit, Ontario, was expected to effect delivery of Western Canadian crude to British American Oil Company's refinery at Clarkson by about October 1 and to Regent Oil Company's Port Credit refinery about November 1. A 3800-hp electric pumping station and three 120,000-barrel storage tanks were being built at Sarnia . . . A 1½-mile south stepout, White Rose-C & E Innisfail 11-3-35-1 has indicated production in the Devonian Reef in which 148 feet of oil pay was found in the discovery well. The location is northeast of Sundre-Westward Ho in southwestern Alberta. Casing was being run to the top of the pay, in which gas was found, preparatory to coring and testing the remainder of the reef section.

CHILE: Survey of the right-of-way for the proposed 75-mile, 10-inch products pipe line from Concon refinery in Chile to Santiago has been completed. Manufacture of the welded pipe will take place in Chile.

CUBA: Consolidated Cuban Petroleum Corporation has completed its twelfth test well in Cruz Verde field area. The best well yet completed in the field, the new test is estimated to be capable of 1000 barrels per day oil production . . . Exclusive of the new well, Consolidated reports production of 128 barrels per day . . . Three Consolidated-owned rigs are being run in the Bacuranao area. A wildcat location was being prepared several miles south of Cruz Verde field . . . In Las Villas Province, Cuban Gulf Oil Company abandoned a projected deep test at 5200 feet after an unsuccessful fishing job.

ECUADOR: California-Ecuador Petroleum Company encountered oil and gas shows at 2000 feet in a wildcat being drilled 35 miles southwest of Guayaquil in the Progreso Basin of Southern Ecuador. The test, Santo Domingo 1, is being drilled by Santa Fe Drilling Company with a rig capable of 10,000 feet, at a location about 75 miles from the nearest production.

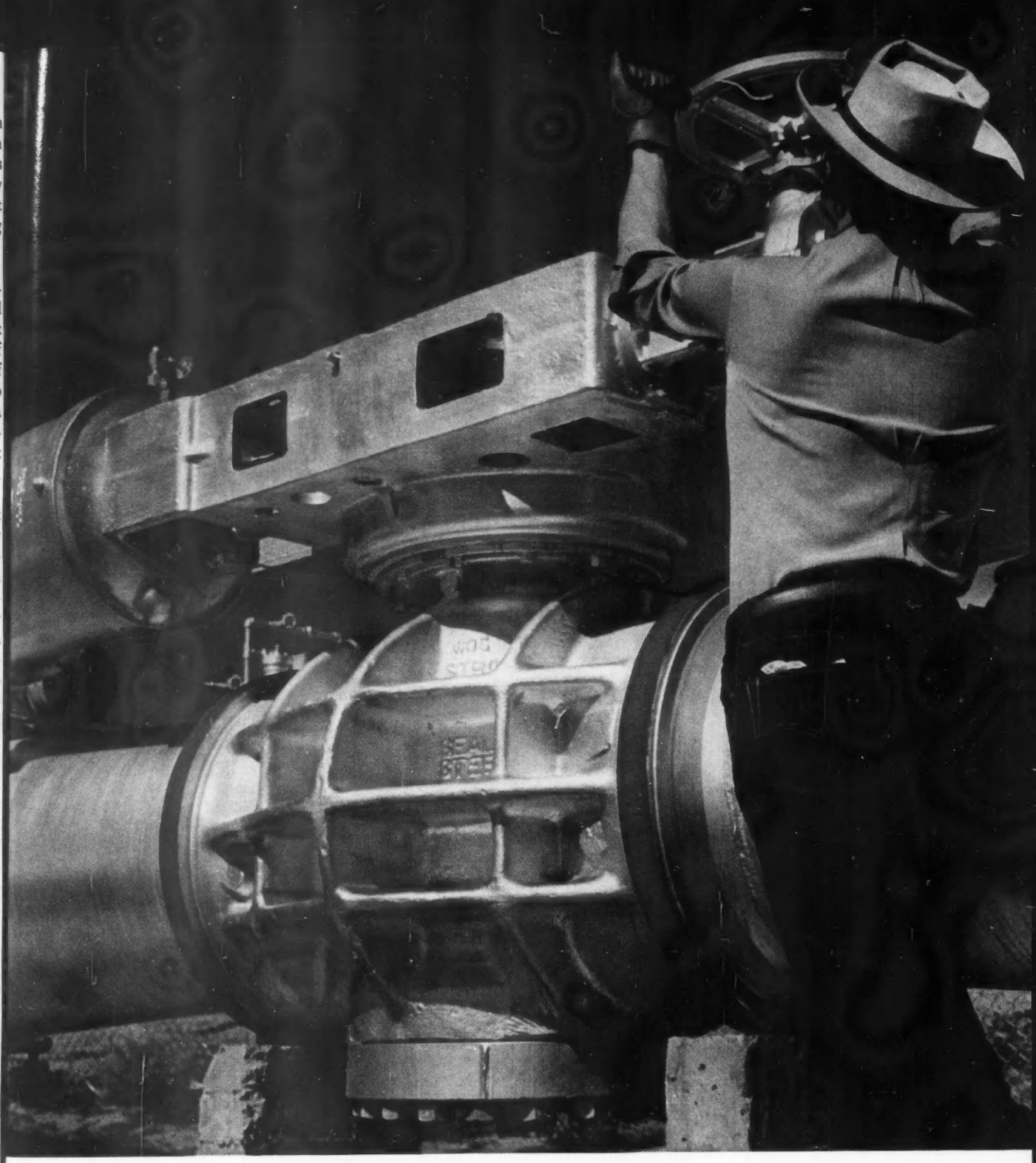
ENGLAND: Work was under way at the site of British Petroleum Company Limited's new crude oil tanker terminal at Popton Point on the south shore of Milford Haven, Pembrokeshire, in Wales. BP will build a new jetty to accommodate supertankers, a tank farm, and will lay a 60-mile, 18-inch pipe line with a capacity of 100,000 barrels per day, through Pembrokeshire, Carmarthenshire and Glamorgan to the Llandarcy refinery.

GERMANY, WEST: Deutsche Erdoel AG's offshore test, about 700 feet from shore to a depth of about 5100 feet, reportedly resulted in a small oil producer. The location was near Kiel . . . Another German company, Gewerkschaft Elwerath was scheduled to drill an offshore test in the North Sea.

HONDURAS: Barnwell Offshore Inc. of Shreveport, La., has contracted with Compañía Petrolera Hondureña for the drilling of two 15,000 foot tests, one to commence offshore by Aug. 1, 1958, and the other onshore.

INDIA: Indo-Stanvac Petroleum Project spudded its second test located eight miles north of Galsi and 90 miles northwest of Calcutta, known as Galsi 1 . . . Burdwan 1, located 21 miles southeast of the new test, was abandoned in early August at a total depth of 8921 with no shows reported. Igneous rock was encountered at 8350 feet.

IRAN: Crude oil production in South Iran in July, 1957, passed the pre-Nationalization record established in 1950. Daily average production this past July was 756,000 barrels per calendar day. Crude runs at Abadan av-



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The lubricant in Rockwell-Nordstrom valves does another important job: it eliminates metal-to-metal wearing friction for longer valve life. Yet with all their obvious advantages, Rockwell-Nordstrom valves cost no more to buy, often less, than ordinary valves. Rockwell Manufacturing Company, Pittsburgh 8, Pa.

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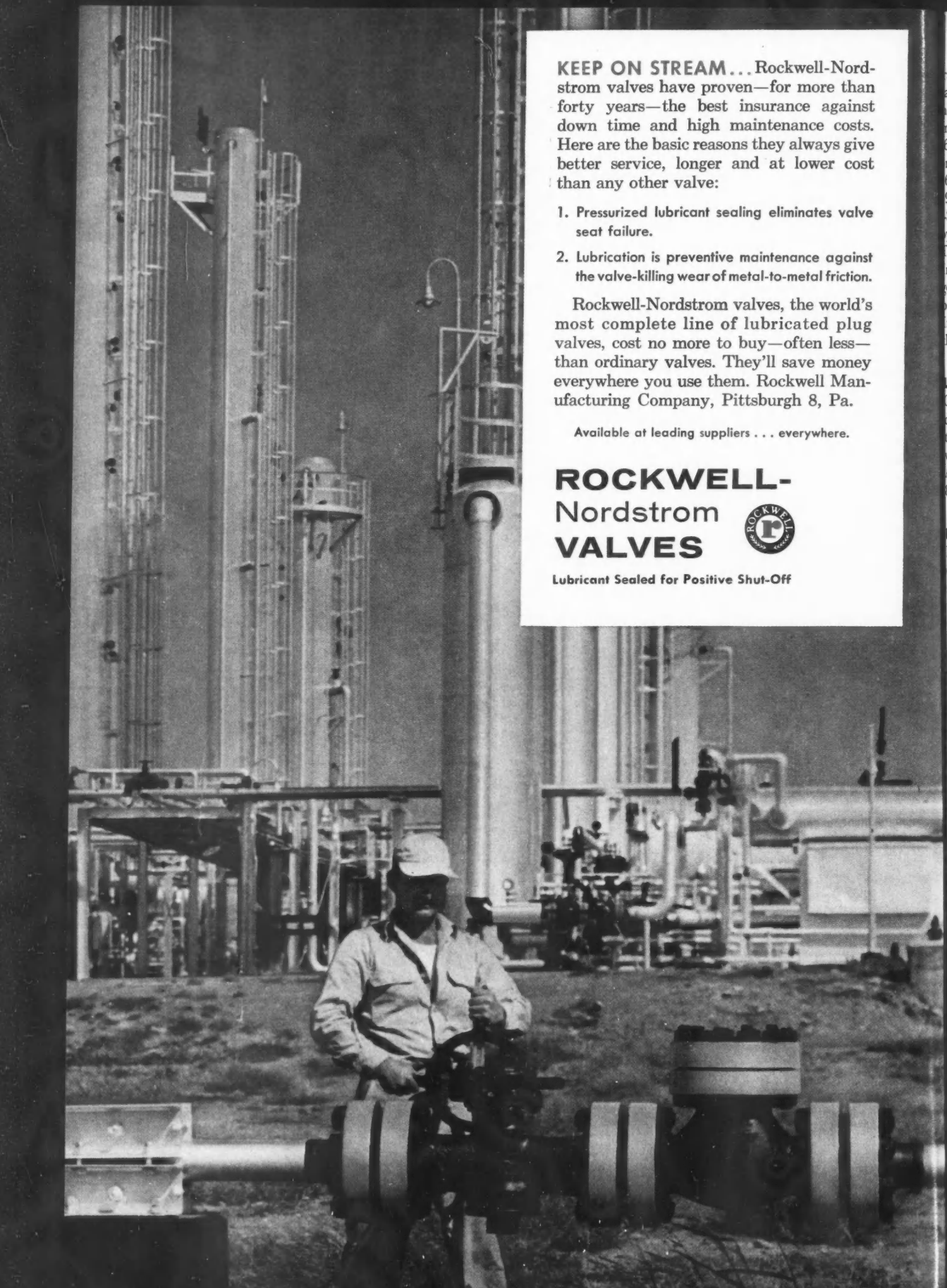

KEEP ON STREAM... Rockwell-Nordstrom valves have proven—for more than forty years—the best insurance against down time and high maintenance costs. Here are the basic reasons they always give better service, longer and at lower cost than any other valve:

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ROCKWELL-
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VALVES

Lubricant Sealed for Positive Shut-Off

raged 284,000 barrels per calendar ay at the same time. During the six-onth period ending July 31, crude roduced in South Iran aggregated 6,910,000 long tons, surpassing the revious high six months total of 16,-67,000 long tons for March-August, 950. The latter figure included Naft-Shah field production, now operated y National Iranian Oil Company . . . The agreement between National ranian Oil Company and the Italian overnment exploration trust, AGIP, ecame legal upon passage of the new ranian oil law and was ratified by he Persian Senate.

LEBANON: Trans-Arabian Pipe Line Company reported an average daily delivery of 347,301 barrels of crude oil to Sidon, Lebanon, from Saudi Arabia via Tapline during August, 1957. In August, 1956, a daily average of 351,-856 barrels was moved to Sidon.

LIBYA: Esso Standard (Libya) Inc. Haghe 1 in the Fezzan reached total depth of 3385 feet in basement, considerably shallower than expected; it was hoped that as much as 5500 feet of sedimentary section would be found. The well was plugged back preparatory to testing shallow oil and gas shows previously encountered.

SAUDI ARABIA: Only five months after the new 22-inch crude line from Safaniya field to Ras Tanura went into operation, Arabian American Oil Company had advanced plans both to increase its capacity and to loop it with a new 30-inch line. A new pump station, located at the approximate mid-point of the 137-mile line, will be constructed, utilizing three 900-h.p. crude oil-burning centrifugal pumps . . . Some 30-inch pipe for the new parallel line already is in Saudi Arabia and the remainder was being purchased in the U. S. and in Europe . . . Installation of the new pumping station in the "old" line is expected to boost capacity from 125,000 barrels daily to 190,000; after construction of the new 30-inch line, the Safaniya-Ras Tanura pipe line system will exceed 400,000 barrels per day capacity. Crude oil to be produced at the new Khursaniyah field, a 1956 discovery, is likely to be pumped through the same system.

Natural Gas Found in Israel; Two New Oil Wells Reported

Natural gas reportedly has been found in Israel, and a fire, started at the gas site in Be'eri by a test drill spark, was extinguished after burning 24 hours.

It was also reported that a new oil well had been brought in at Heletz field, 30 miles south of Tel Aviv, and another one at Brur field, about a mile and a half south of Heletz. They bring to 21 the number of wells so far in the two fields which have reached production at the rate of about 600,000 barrels a year, about 6 percent of Israel's total petroleum requirements.

Israel Oil Prospectors Corp., Ltd., a private group of U. S. investors, are partners with Lapidoth Israel Petroleum Co., Ltd., in Israel's only producing oil wells.

The fire at Be'eri, in the Western Negev about 11 miles south of the Heletz field, was entinguished by an Israel Air Force plane using a high pressure spraying apparatus. Flames

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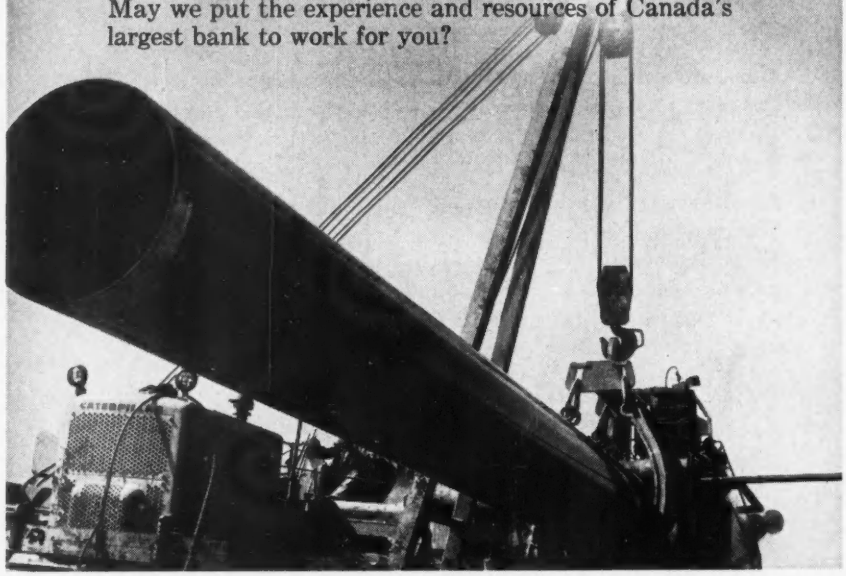
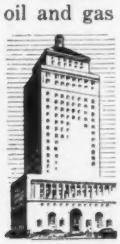


Write to The Royal Bank of Canada, Oil and Gas Department, 409 Eighth Avenue West, Calgary, Alberta, for a list of current *"Oil and Gas Bulletins"*. These "Bulletins" are revised constantly, will bring you up to date on regulations, tariffs, oil and gas financing, basic statistics, and kindred subjects.

We do not provide information on oil securities.



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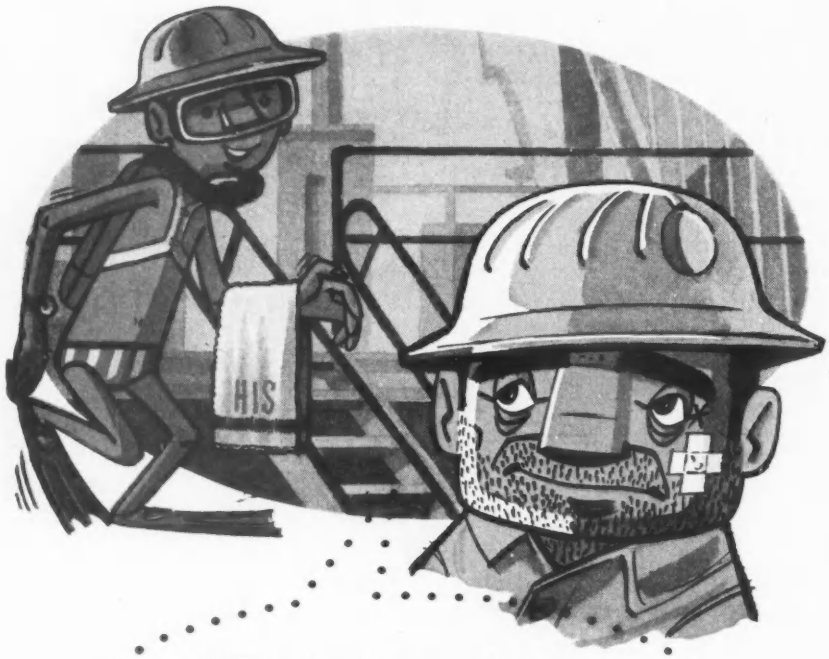

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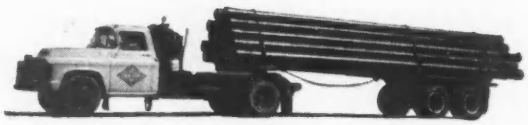

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rose more than 120 feet and could be seen ten miles away.

After the fire was extinguished, the gas flow was capped until further tests could be made.

The new well at Brur field found oil at 5000 feet, while oil was found in the Heletz well at 4930 feet. There now are 18 producing wells in Heletz and three at Brur.

Barnwell Offshore, Inc., Acquires Honduras Interest

Barnwell Offshore, Inc., Shreveport, La., has acquired a one-half interest in a 51 million-acre oil, gas and mineral concession in Honduras, Central America.

The concession, covering both land and offshore area, lies in the Departmentos of Comayagua, Cortes, Atlantida, Colon, the Mosquitia Territory, (now Gracios A Dios), the Bay Islands, the Continental Shelf Tidelands and Territorial Seas on the Caribbean, bordered on the west by Guatemala and on the east by Nicaragua. It will be owned in conjunction with Compania Petrolera Hondurena, S. A., of Honduras. Preliminary geological work has been done on the concession and it is reported several likely structures have been found.

A well reported drilling below 12,500 feet offshore near Punta Gorda in Nicaragua is located not far east of the easternmost boundaries of the Barnwell concession. A well also is reported preparing to drill in Southeast Guatemala just west of the State of Cortes and the western boundary of the concession.

R. S. Barnwell, Jr., president of the firm, said that as soon as all legal requirements in connection with the acquisition of the concession have been completed plans will be developed for an exploration program.

It is expected that this program will involve the use of the company's mobile offshore drilling barge now under construction in the LeTourneau yards, Vicksburg, Miss.

3 Gas Discovery Wells Are Reported in Canada

Three recent natural gas discoveries, one of which also was a light oil discovery, have been reported in Canada.

The two gas discoveries were:

1. The British American-Triad-et al Lovett River 12-30, located 36 miles

From fly-wheel to drive-wheel
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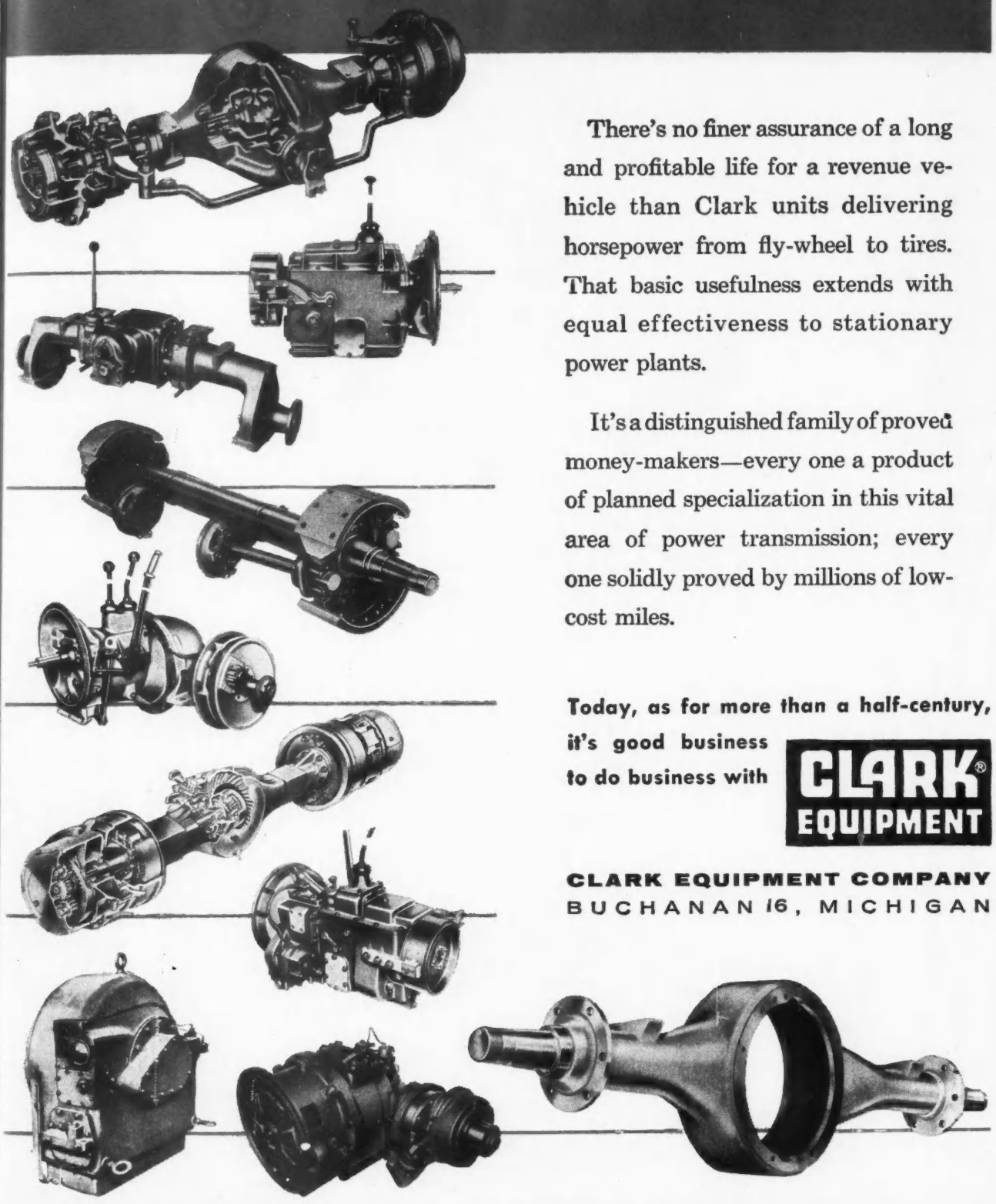

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When a conventional pump becomes loaded with gas, a gas lock frequently results, and high static pressure on the traveling valve makes this gas lock difficult to break. In the Ratio-Compound Pump, this high static pressure is carried by the top traveling valve, and during the downstroke the second stage pulls a suction on top while the first stage applies pressure below the intermediate traveling valve. Therefore, it opens promptly at the beginning of the downstroke even if the pump is filled with foam or gas. The improved valve action eliminates gas lock and improves pump efficiency.

A bonus feature of the novel two-stage design is the absence of gas or fluid found in the low efficiency range. Static pressure acts on the hollow polished rod when the top traveling valve is closed and actually pulls a tension in the rod string during the downstroke, resulting in improved plunger travel, decreased load range on the rods, reduced torque on the unit gear box, and lowered horsepower requirements on the prime mover.

Don't puzzle over the problem of pumping foamy or gassy oil. Call your Oilmaster Representative and ask him about the Ratio-Compound, or write Fluid Packed Pump Co., Box 64, Los Nietos, California for literature.

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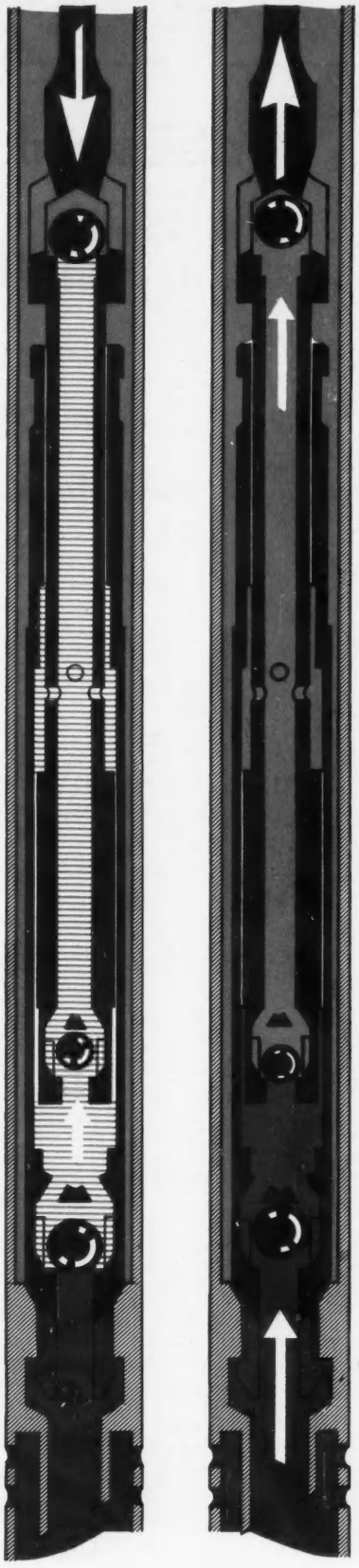

On the upstroke, fluid and gas enter the pump through the standing valve into the full area of the barrel underneath the plunger. This is the first stage chamber. At the beginning of the downstroke, the top traveling valve closes, and the gas is compressed and the fluid displaced into the second stage chamber which is the annular area between the hollow polished rod and the barrel above the plunger. On the subsequent upstroke the top traveling valve opens and the annular chamber discharges the fluid and compressed gas into the tubing.

Published October 1957

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northwest of the initial discovery well, Stolberg 6-10A, drilled by the Central Foothills Agreement Group of Calgary.

The new well has a gas flow potential of 4.7 Mmcf daily. The Stolberg well has a potential of 8.5 Mmcf daily.

British American Oil Co., Triad Oil Co., Sun Oil Co. and Royalite Oil Co. each holds a 25 percent interest in the agreement group.

2. The Viking Northwest Bindloss 6-12, a three-mile step out to the Bindloss gas field in southeastern Alberta, drilled by the New Chamberlain group. On test, the well flowed at the rate of 3.8 Mmcf daily from depth of 3485 feet, indicating extension of a field which will supply Trans-Canada Pipe Line Company.

The Viking sand gas and light oil discovery in the Garrington area, 60 miles northwest of Calgary, has been termed an important discovery. The well is Hudson's Bay-New Superior-et al Garrington 12-26-34-5 and is located three miles northwest of the New Superior et al-Hudson's Bay 4-20 discovery, which was completed as a Viking gas well.

The Garrington well, during a drill-stem test at the 8045-8094-foot interval, flowed gas at the rate of 7 Mmcf daily, and gave recovery of 240 feet of 47-gravity crude. The well was being drilled on to the Mississippian limestone which was expected to be found at about 9000 feet.

Bulgaria Claims Crude Production Is Rising

Recently, official Bulgarian sources said that domestic crude output during the first half of 1957 reached a total of 986,426 barrels, or about 5450 barrels per day. This was described as an increase from the 1956 yield of slightly more than 1.7 million barrels, or about 4650 barrels per day.

Another report indicated that Tshulenovo oil field, center of crude production in Bulgaria, currently has 106 crude producing wells. Of the total of 158 wells drilled to date, 52 have been dry.

Average depth of crude-producing zones ranges between 1180 feet and 1315 feet. However, since geologists believe that producing formations exist beneath the shallow level, a deep test—R-40—has been scheduled to drill to 10,365 feet.

One of the Shell drilling barges on Lake Maracaibo. Four Paxman sets provide power for the slush pumps and two more Paxman engines drive alternators for power and lighting. (B. P. photograph)

OIL... *in Western Venezuela*

Crude oil output in Venezuela, one of the world's leading producers, comes mainly from the western part of the country, in the Lake Maracaibo area, although fields in Eastern Venezuela contribute approximately a third of the total production.

Amongst the diversity of drilling equipment in service in this oil-producing area, Paxman diesels are doing a job of unfailing service driving draw-works, rotary tables and slush pumps, both up country and on offshore rigs. These engines come from a range of "Drilpak" sets, developed from 16,000,000 hours drilling experience, known by oil men everywhere for their sound performance, rugged construction and dogged dependability. Paxman engines for oilfield duty are built in two power ranges. Engines having a common bore of 7 inches give you a power range of 100 - 1,000 b.h.p. In the 9¾ inch bore range of fabricated steel framed engines an output of 480 - 2,100 b.h.p. is available.

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A Paxman engined Cia. Shell de Venezuela deep drilling rig at La Paz field. (From a B. P. photograph)

Petroleum Industry Consultants C.A., operating in Maracaibo and Caracas, carry a full stock of spares for Paxman engines.

J.41.

After 15 months' service... Gathering lines of NATIONAL* PVC PIPE show no paraffin build-up!

In October 1955, the TXL Oil Corporation installed a 2,800-foot gathering line of USS NATIONAL Polyvinyl Chloride Pipe in the Permian Basin, 12 miles south of Odessa, Texas. Metal pipelines, previously used for this application, had required frequent steaming out to remove paraffin build-up which plugged the line.

Upon inspection of the NATIONAL PVC line, in January 1957, after 15 months of continuous service, the following was revealed:

a. Despite heavy, year-round use, the PVC line showed no evidence of paraffin build-up.

b. There had never been any reduction in flow.

c. The engineers responsible for installing the NATIONAL PVC line agreed that it had definitely solved a paraffin problem. They recommended it for future similar installations.

This 2,800-foot line of NATIONAL PVC Pipe was laid in *1¾ hours*. Average service temperature is 75°-80°F. Pressures average from 30 to 40 pounds.

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Send for Bulletin No. 24 and get the full story on USS NATIONAL PVC Pipe. Write to National Tube Division, United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pa.

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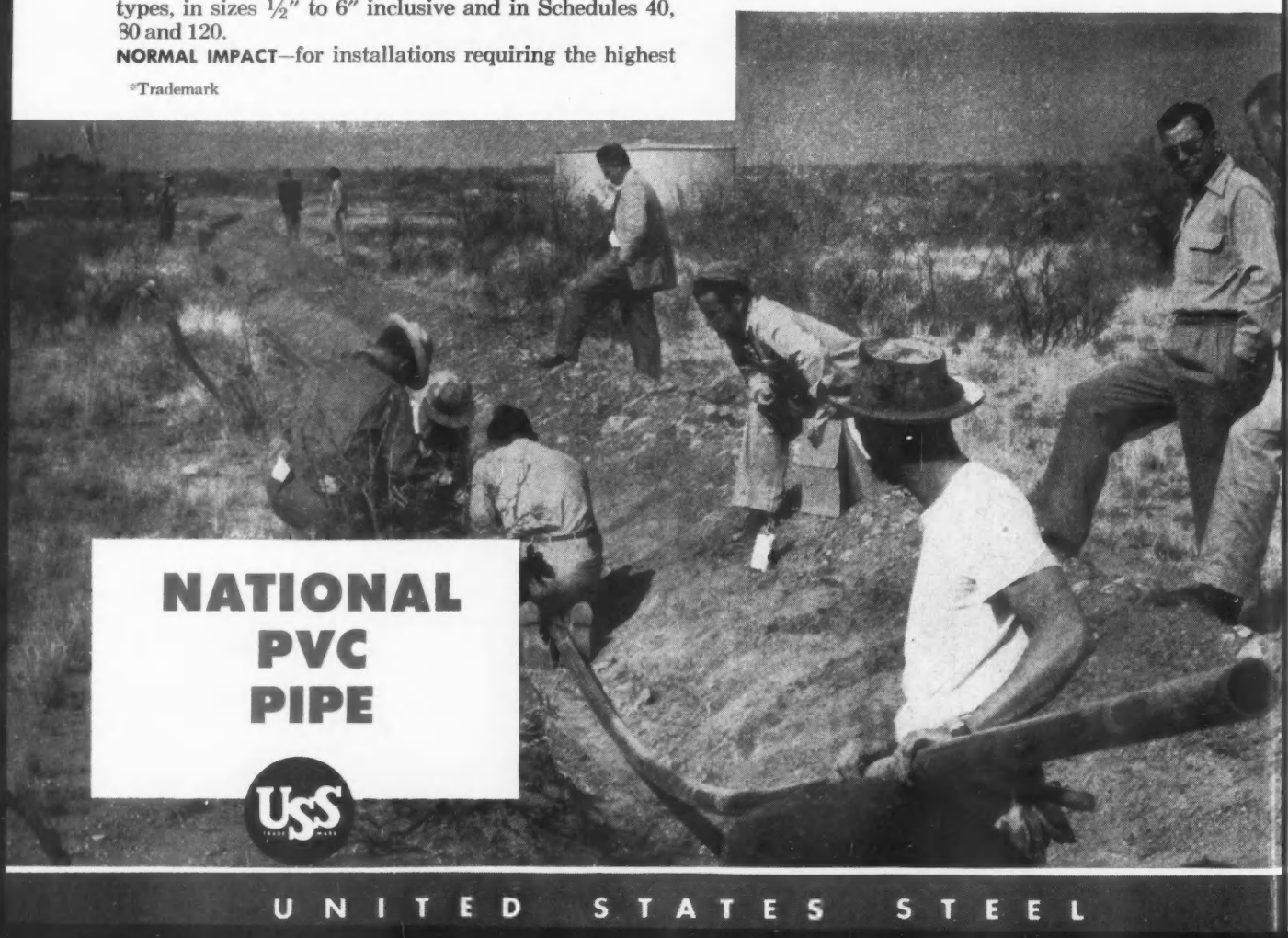

UNITED STATES STEEL

Mexico's Natural Gas Industry Is Expanding

A new chain of production and distribution has been established in Mexico, with the completion of an adsorption plant at Ciudad Pemex, in the south-eastern state of Tabasco. The plant will be able to process 300 Mmcf. of gas daily, obtained from 70 wells in the immediate neighborhood. Forty of these wells were ready to go into production on July 1.

Petroleos Mexicanos, government oil agency, is investing $23 million in the adsorption plant; a complementary processing plant at Minatitlan; an oil pipe line from Ciudad Pemex to Minatitlan; the drilling of the wells that will feed the adsorption plant; and on the preliminary development of Ciudad Pemex as a new and important center of PEMEX activity as well as of population.

Production at Ciudad Pemex will be widely distributed. A gas line has been laid into the state capital of Tabasco, and it also will supply a number of sugar mills in the region. Gas will be piped into plants built by the booming sulfur industry in Minatitlan.

Construction was planned of a gas pipe line into the port of Vera Cruz, and later, at a cost of about $32 million, Petroleos Mexicanos will build a gas pipe line 625 miles through the industrial zones of Cordoba, Orizaba and Puebla, into Mexico City.

New Producing Area Draws Mexico Interest

Less than five miles from the San Andres field, Petroleos Mexicanos has begun producing new fields—El Hallazgo.

As many as 16 rigs have been in operation at El Hallazgo in one month, and Petroleos Mexicanos asserted that, with the San Andres field, the discovery will prove to be the most important one since nationalization of the industry in 1938.

El Hallazgo now is producing a daily average of 19,000 barrels. The first well was brought in at 10,397 feet, with production of 1100 barrels light oil daily.

The discoveries at San Andres and El Hallazgo indicate that the area south of the Tecolutla River, southeast of the city of Papantla and all the way to the Gulf Coast, might become an important center of production within the next five years, according to Pemex officials.

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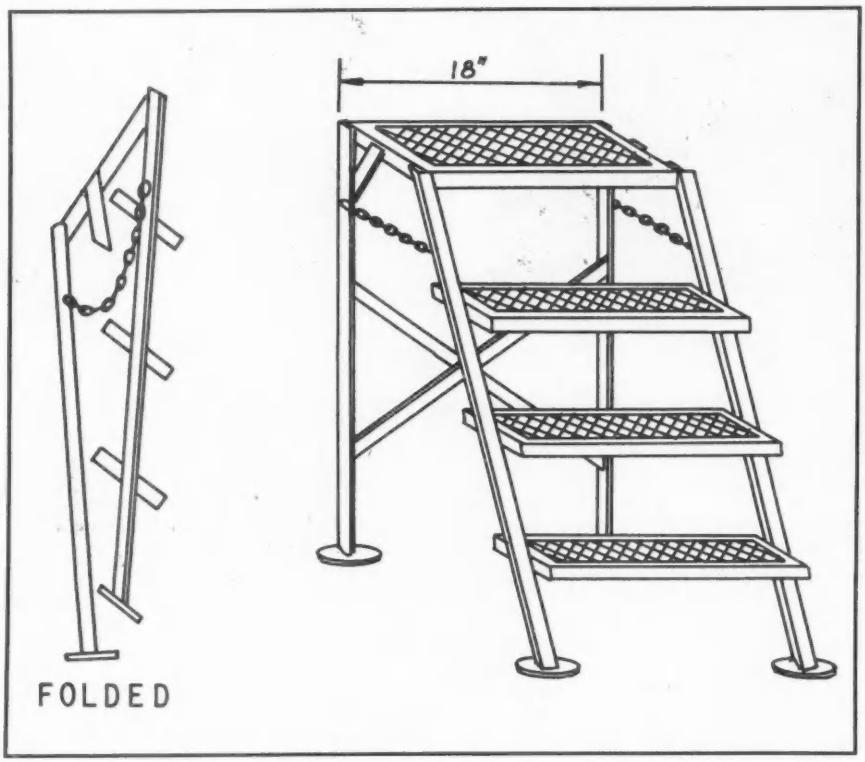

Folding Step Ladder Helps Wireline Man

A bottom hole operator must stand on top of a wellhead and raise a lubricator some seven feet long weighing approximately 90 pounds. In many cases the top of wellhead is six feet or more above ground. As there is considerable equipment which must be carried in a bottom hole wire line truck, it was necessary to have steps which do not occupy much space and still be strong enough to hold a man and a lubricator, and sturdy enough to give good balance and footing. Such steps are shown in the picture.

They provide the following advantages: Light enough that they can be carried by hand; very compact, utilizing little space when folded; give good footing and balance even when set up on uneven ground, or under muddy or icy conditions; sturdy in that they cannot be broken by rough handling; can be utilized on any job in which additional height is required or desirable; additional height gained by the steps allows the operator to place lubricator on wellhead without raising it above his head, thereby less likelihood of strain; in many cases one man can raise lubricator onto high wellheads, whereas without steps, two men would be required.

Mesh Container Reduces Breakage of Rig Lights

Reasonable care taken in the handling and moving of rig lights and cables can repay the effort many times over in reduced breakage, loss and pilferage. A Four Corners area drilling contractor has adopted the

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WORLD OIL editors want how-to-do-it ideas, so your favorite short cut or invention could put money in your pocket! Write down the substance of your latest ideas and send them in with a picture or drawing of the installation . . . if accepted, $10 for each idea will be yours. Send those money-making ideas today to Hints Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas.

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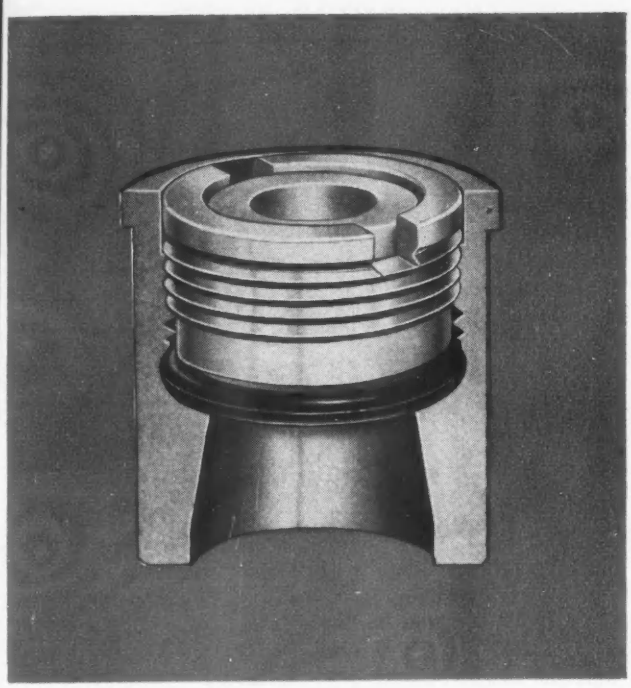

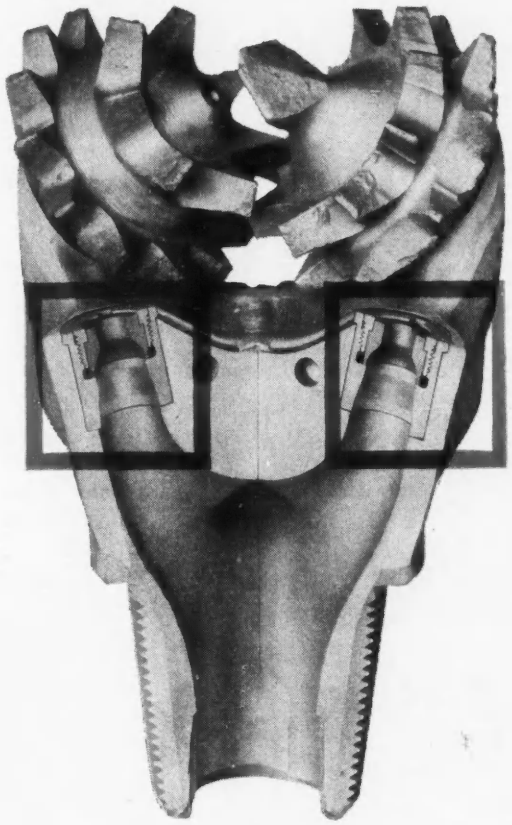

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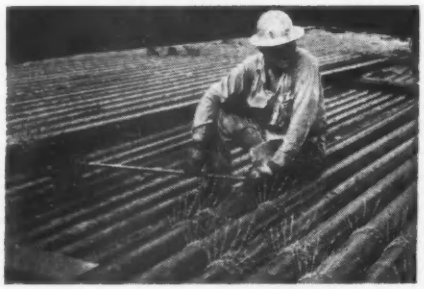
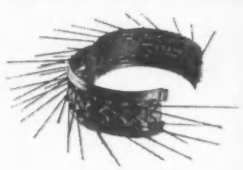
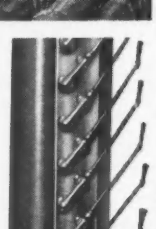




B & W Hinged Nu-Coil Scratcher



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practice, at moving time, of storing all such materials in a light but sturdy rectangular container which was specifically designed for the purpose.

Shown in the photograph, the all-welded, shopmade container is built largely of angle iron, with sides, ends and top panels made of heavy expanded metal. Base of the unit is of two-inch pipe. The top panel is divided into two sections, each hinged at the center, permitting access to either end of the container.

Several advantages accrue from the use of this type of container. Having a place especially designed for such fragile equipment encourages proper handling and storing. Since the panels are "open," the contents are easily checked to see that all items are accounted for, and at rigging-up time the crew can more easily sort out and select the various items needed. The mesh panels, revealing the breakable contents, encourage more tender handling by truck and crane operators. A lifting eye in the top center of the unit, plus a pair of hand-holds at each end, further assist in careful handling.

Build Catwalk for Working On Stand Pipe Connections

It is not an uncommon sight to see a derrick man with his legs wrapped around derrick girts, working on the standpipe clamps or brackets or changing a leaking chicksan where the rotary hose connects to the standpipe. This is a very unhandy job as well as being quite hazardous when working from this position.

One operator has installed 3 inch by 12-inch boards in the corner of the derrick just below the standpipe connection. These boards are used as a type of catwalk for the roughnecks to stand on when tightening or making up standpipe clamps, changing out or tightening chicksan unions, or when it is necessary to replace or repair the rotary hose. These 3 by 12-inch catwalk boards are anchored to the derrick girts with "J" bolts that can be homemade from ¾-inch stock.

This simple device has made this type of hazardous work a little safer and gives the derrick men or crewmen a better footing and a safer place to work when performing their job.

Join Rack With Unions To Simplify Handling

A pair of hammer type unions incorporated into the design of the drilling line spool rack can result in much easier handling and moving of that piece of equipment. Illustrated in the photograph, the rack is built of salvaged pipe and is welded together in the conventional manner except for the two principal horizontal members, the latter being cut in the center and joined together by the two unions.

Broken down into two easily-nested pieces, the rack not only is easier to handle, but is more easily loaded on small truck beds, pipe basket or the skid-mounted equipment bins commonly employed for smaller items. The pipe axle on which the spool turns is supported by a sleeve or cradle on either side of the rack.

To reduce cost of construction, the unions might be taken out of salvage, using those which no longer are suited for high pressure but which still would be amply strong for structural purposes.

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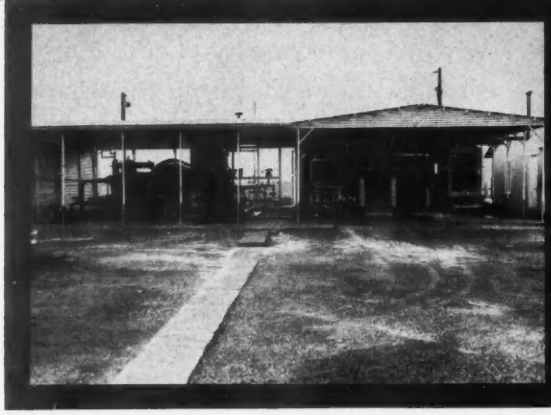

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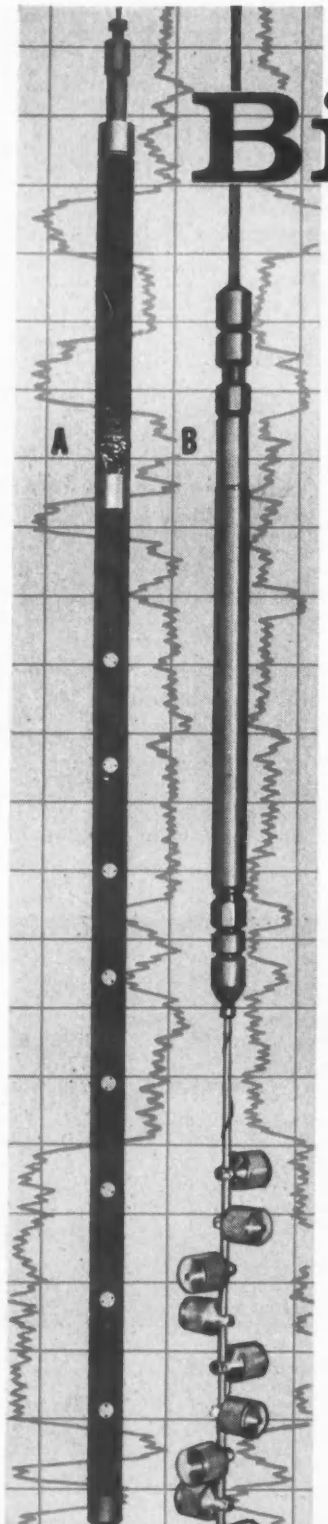

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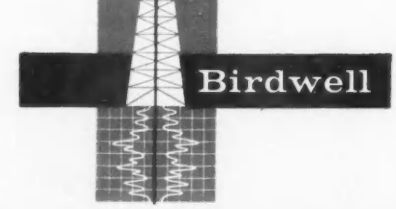
Only BIRDWELL can offer this experience in Gamma Perforating, assuring accuracy, penetration and economy. After three years of field experience this technique has become standard practice where small pay zones are to be perforated.

It has the economy of providing a Gamma Ray Log for depth correlation in perforating the desired formation with one run into the well. Gamma Perforating is available in Carrier-type, Expendable-type and Swing-type jets. Write for detailed information or contact a BIRDWELL representative at the stations listed.

Photos at left:
A—Gamma Ray tool with Carrier-type perforator.
B—Gamma Ray tool with expendable Selecto Jet charges.



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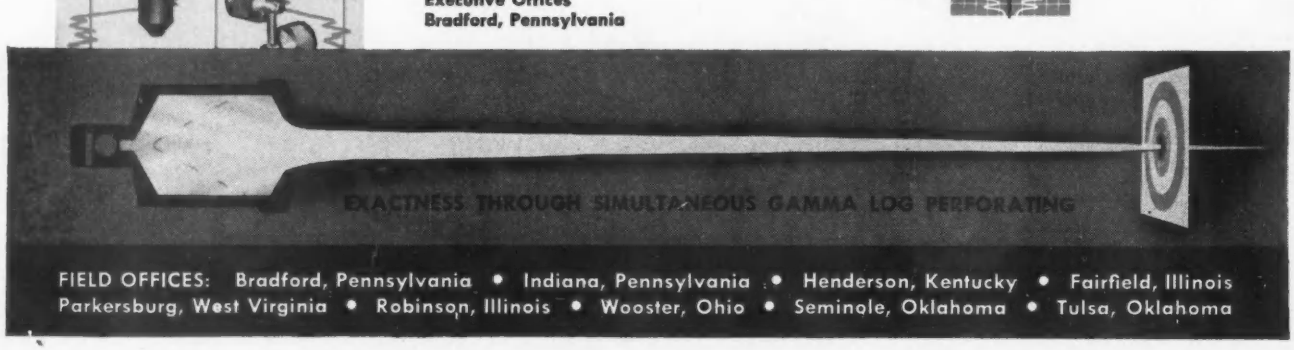

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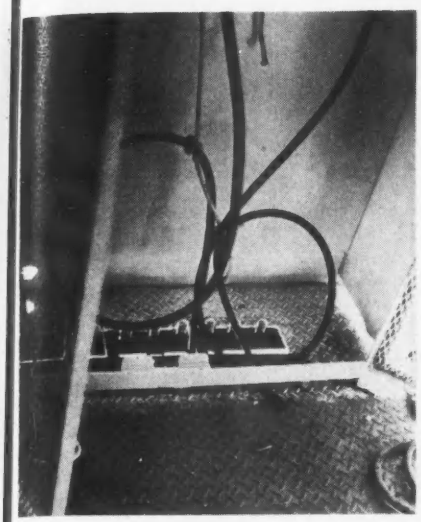


Bring Cables Through Doghouse Trap Door

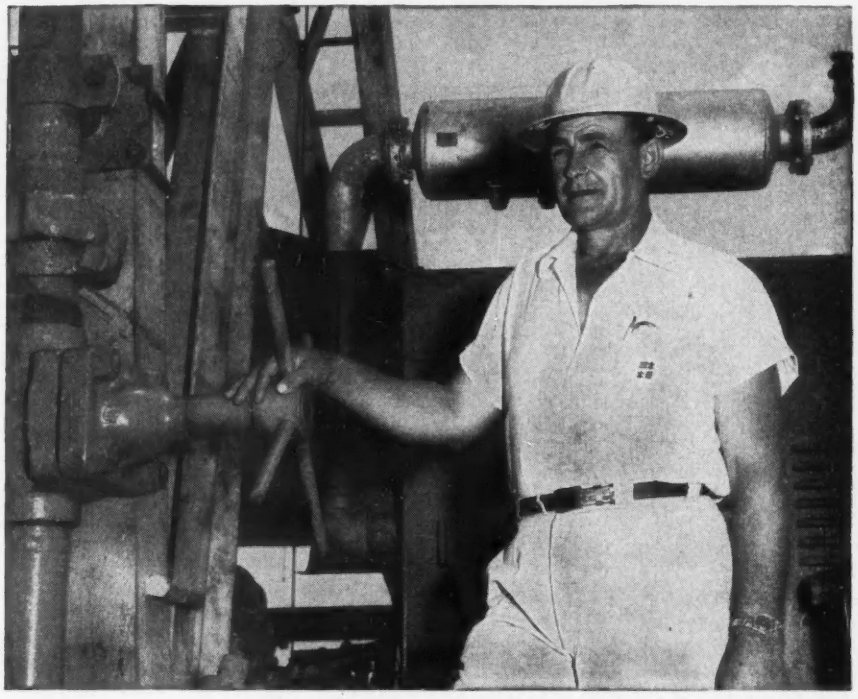
Electric cables, a necessity around any drilling operation, create a problem without proper planning. The photo shows a means of insuring quick, easy installation used by one contractor.

The central electric unit usually found in the doghouse is closeted in a locker that is 18 to 20 inches deep. This locker is built of expanded metal facing on angle iron frames for doors. The doors are shown open in the picture. The outlet in the bottom of the lock is nothing more than a hinge door in the floor of the locker. The construction is very simple.

The hinged door is marked off on the floor of the lockers, then eight to ten holes are drilled on one side with their centers on the line to be cut. When all the holes are drilled, the cover plate is cut from the floor with a cutting torch. This leaves one-half the holes in the floor of the locker, and one-half the holes in the cover plate. The holes would allow cables to go through floor of the box.

However, to protect the cables, short pieces of pipe are cut in half along their length. Half the pipe is welded to the semi-circle in the floor of the locker and the other half welded to the semi-circle in the cover plate. This results in a well-separated exit from the box that also gives good protection to the cables. The door is then welded to the floor by a hinge. This allows the door to be opened easily during rig-up and tear-down so that the large cable connectors can be passed through from outside.

Tips on Mud Valves for Toolpushers . . .



"Woodie" Farris, veteran toolpusher, finds MUDWONDER Valves superior to others he has used

Non-clogging MUDWONDER Valves are real oil field favorites!

by Woodrow Farris, Toolpusher, Rig #3
Kilroy Drilling Company, Alvin, Texas

NEARLY five years ago, I was pushing tools on a Gulf Coast rig. Some of the first test models of the MUDWONDER were installed on it. At first they seemed like just another mud valve . . . but then I noticed the MUDWONDERs simply didn't "sand up" like other types. Began to keep an eye on those Rockwell-built MUDWONDERs . . . and, by golly, they really stood out!

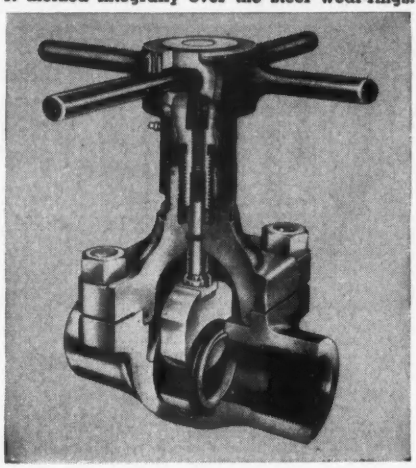
After the second or third hole, we knew we *had* something. The new MUDWONDERs just didn't clog. Even under worst conditions there was never more than a teaspoon of sand in the bonnet—and even this usually flushed free in the flow of mud.

There was no shut-down for cleaning. When essential, repairs could be made without down-time. The one-piece MUDWONDER body stayed right in the line. Rig personnel really *liked* the MUDWONDERs . . . said they were the cleanest and easiest to operate of any mud valves we'd ever used. Yet they cost us no more than ordinary mud valves.

Now, when Kilroy Drilling Company bought our present Rig #3, it was second-hand but almost new. There were a few MUDWONDERs already on it. But on the strength of our experience, Mr. John Baker, Drilling Superintendent, and I both were convinced we wanted MUDWONDERs all the way around. So we re-rigged the whole mudline system that way. Good thing, too. In a year of continuous operation, we've spent virtually nothing on repairs and have had a minimum of maintenance.

MUDWONDER Valves are built in 2", 3" and 4" sizes with screwed or flanged ends for 2000 psi WP (4000 psi test) and 3000 psi WP (6000 psi test). See your favorite oil field supply store, or write Edward Valves, Inc., Subsidiary of Rockwell Manufacturing Company, East Chicago, Indiana. (Adv.)

MUDWONDER cutaway view shows the double thread construction, separated stainless stem and hard chromed gate with "T" slot connection, and the one-piece seat insert with the buna-N molded integrally over the steel wear-rings.



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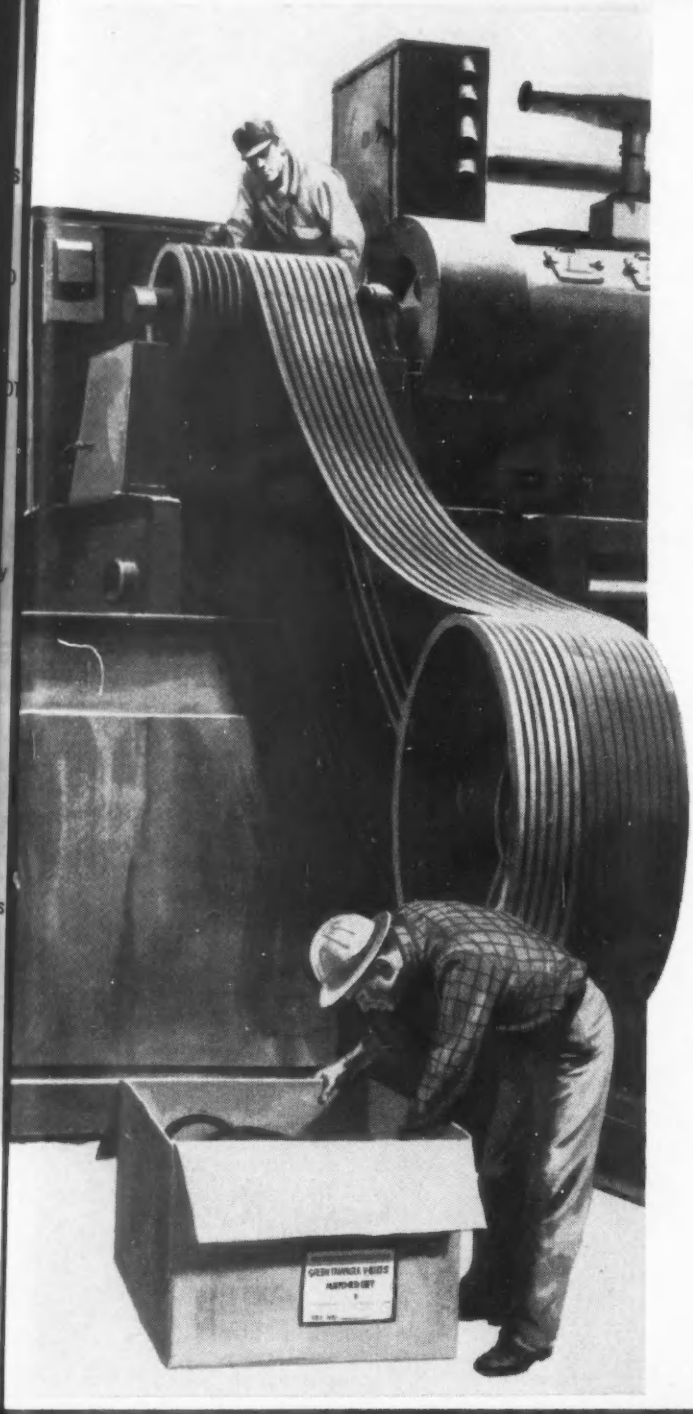

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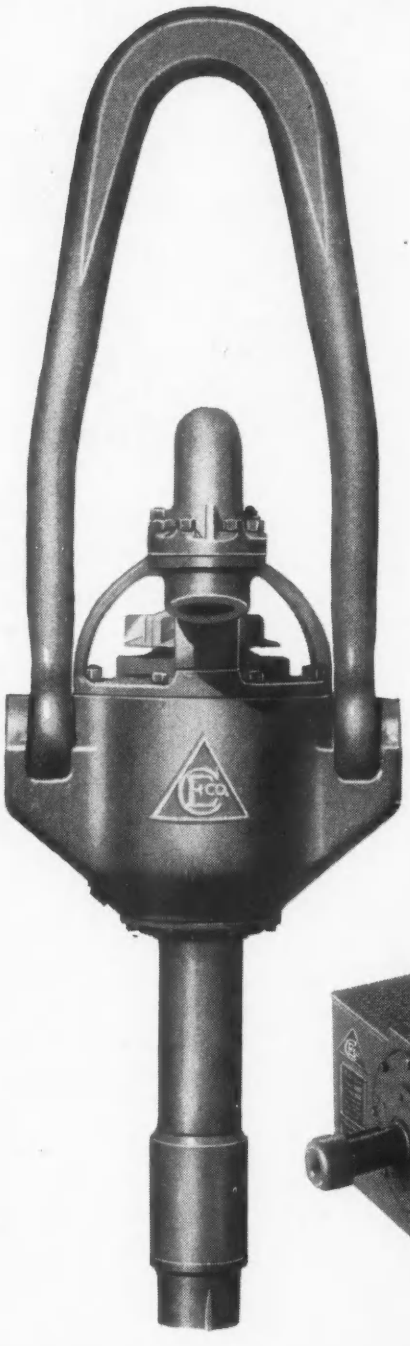
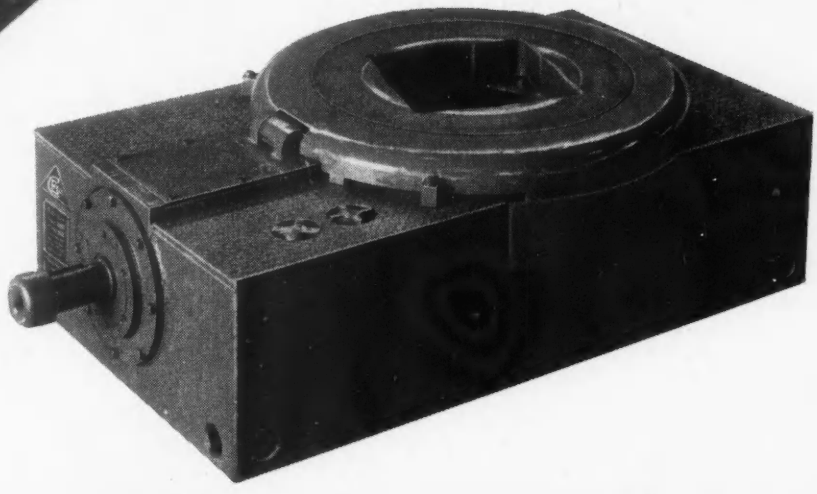


Today's drilling demands modern design

CONTINENTAL-EMSCO Swivels and Rotary Tables

C-E swivels and rotary tables are heavy-duty accessories that work hand-in-hand for faster, high-pressure drilling. They are designed to handle all the demands created by modern drilling . . . longer, heavier drill pipe strings . . . higher mud circulating pressures . . . more drill collars . . . faster trips.

You can depend on C-E swivels and rotary tables to work harder, last longer and require less maintenance. Let your Continental-Emsco man show you how these accessories can help you make more hole . . . and more profit.



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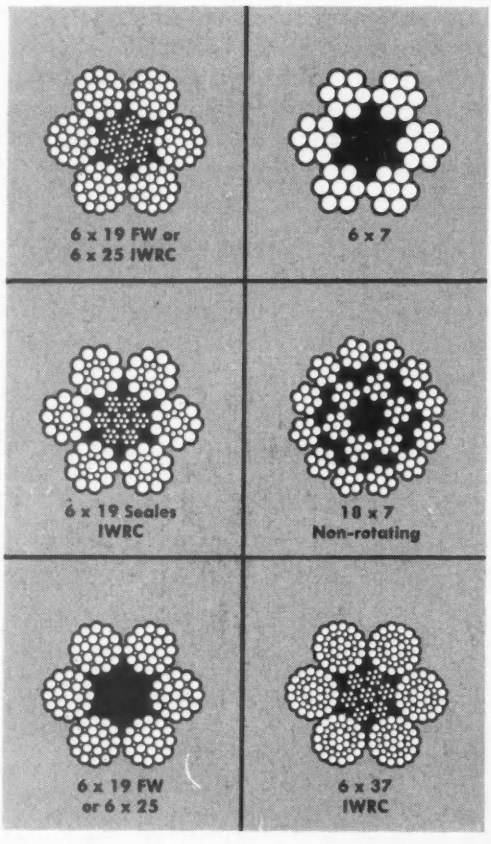

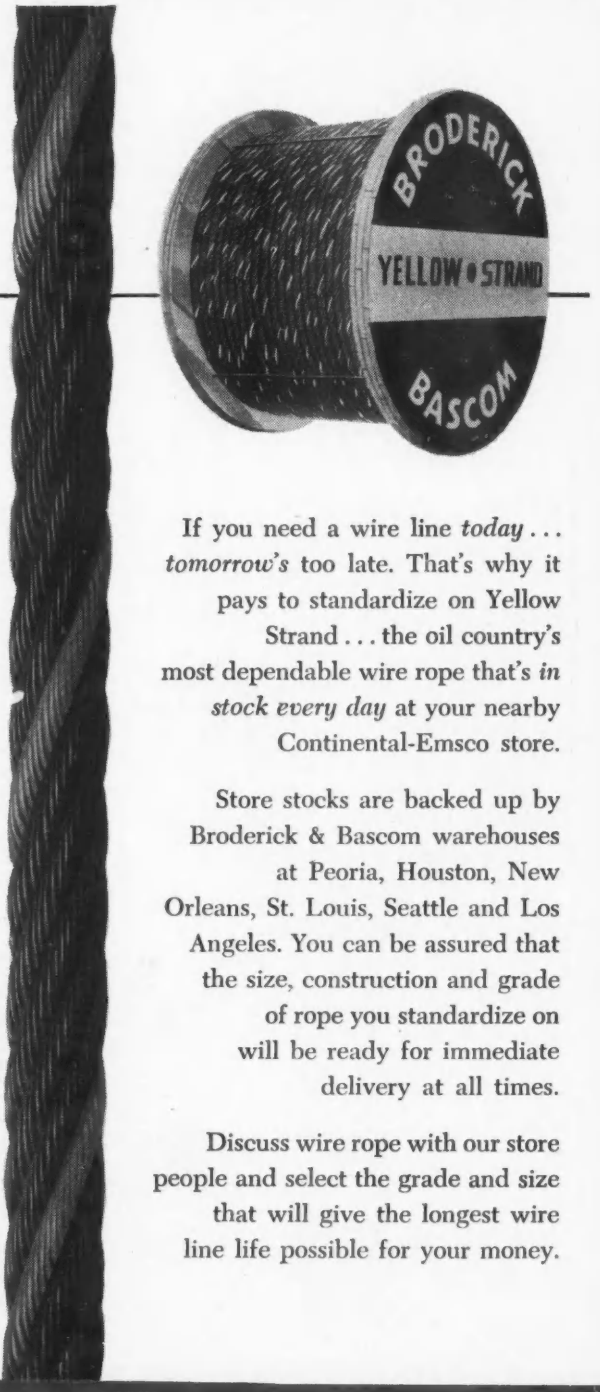

If you need a wire line *today* . . . *tomorrow's* too late. That's why it pays to standardize on Yellow Strand . . . the oil country's most dependable wire rope that's *in stock every day* at your nearby Continental-Emsco store.

Store stocks are backed up by Broderick & Bascom warehouses at Peoria, Houston, New Orleans, St. Louis, Seattle and Los Angeles. You can be assured that the size, construction and grade of rope you standardize on will be ready for immediate delivery at all times.

Discuss wire rope with our store people and select the grade and size that will give the longest wire line life possible for your money.

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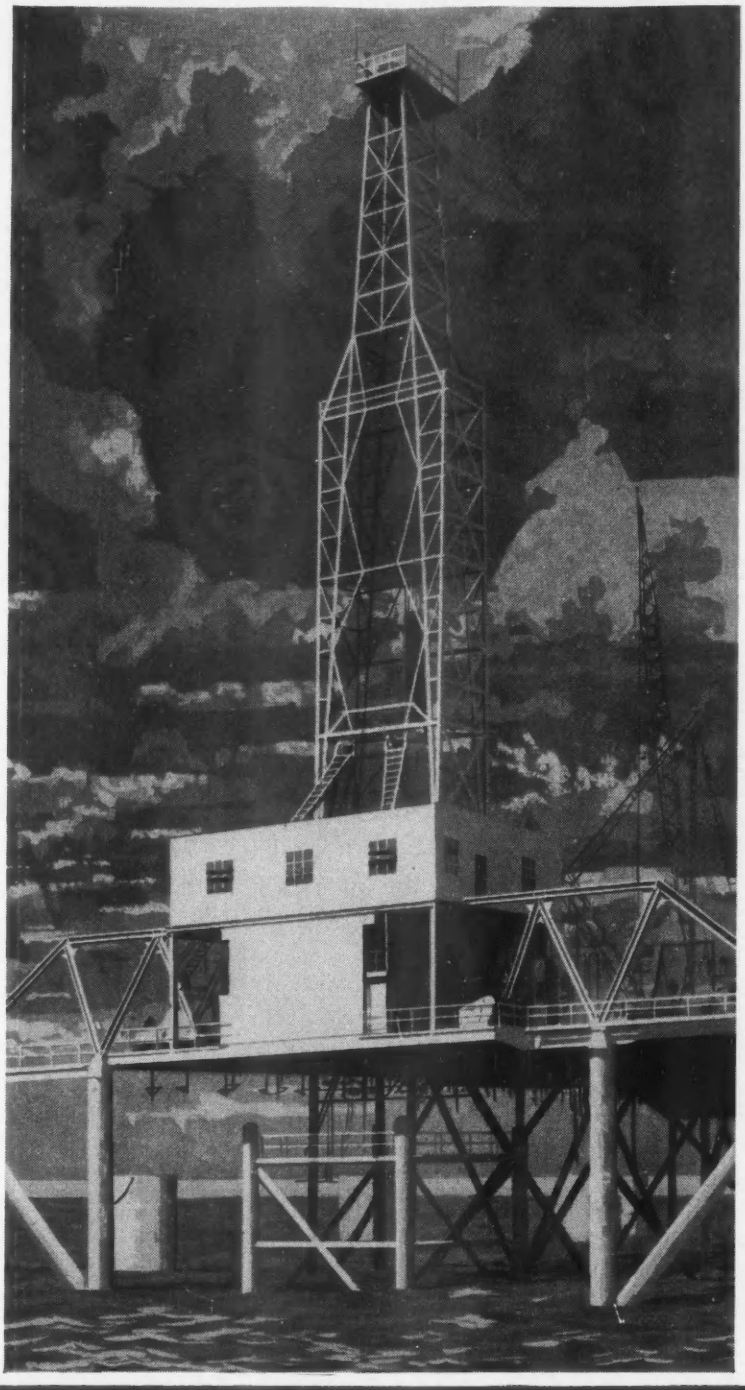

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Faster erection is now possible with these *field proven* features: (1) rear leg pivot and ground level assembly; (2) simplified pin connections for all mast sections; and (3) positive line control during raising and lowering, eliminating the need for snubbing lines.

Positive line control also makes these masts ideally suited for barge installations, since they can be quickly lowered . . . *without snubbing lines* . . . when approaching over-water obstacles . . . or when severe weather sets in.

Discuss your drilling mast requirements with your Continental-Emsco man.

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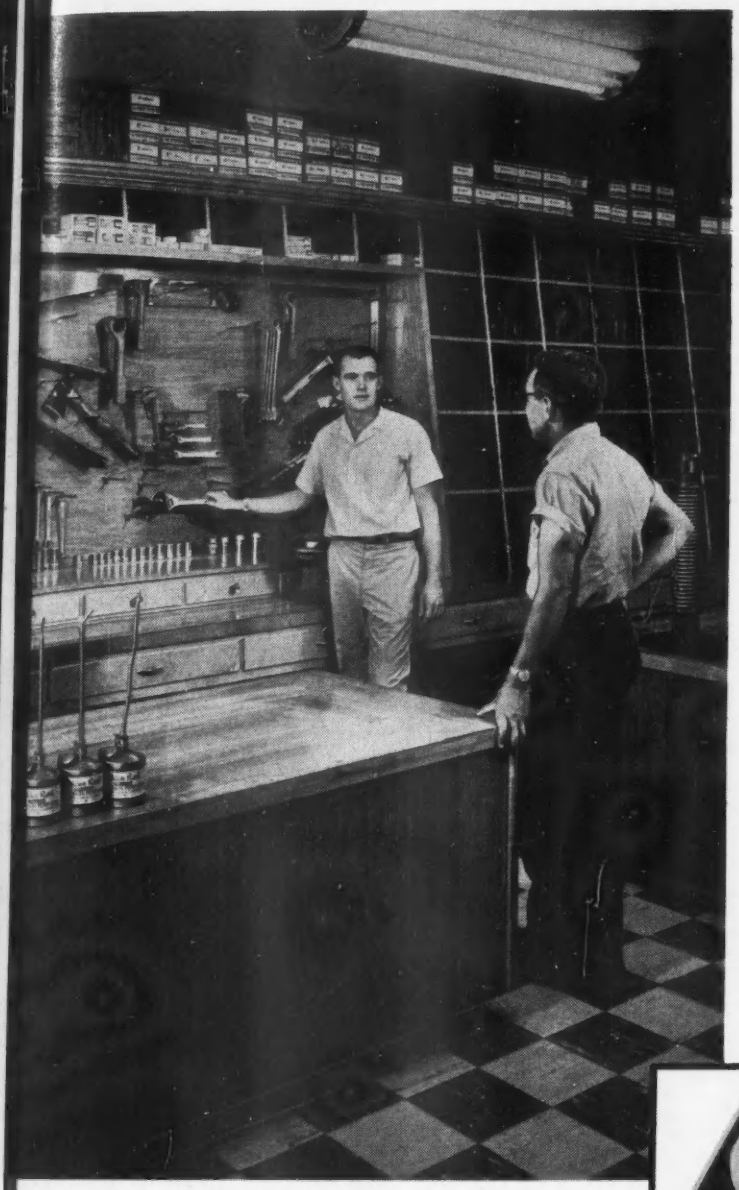
RVICE THROUGHOUT THE DRILLING WORLD



"Jim . . pick out the kind and size you want"

This tool pusher knows that at Continental-Emsco he'll find a wide selection of sizes, types and designs of everything he needs. This wide variety of products saves his time by making *one-stop buying* possible. And he also knows he'll receive prompt, *personalized service* from our store people and continuous follow up and checking of factory shipments.

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V732

By Max Ready—Dale Ledbetter
Johnston Testers

FOR MORE INFORMATION ON YOUR DRILL STEM TEST

A check-off list for reverse circulating drill stem tests

PART II

REVERSE CIRCULATION ON GULF COAST (CASING TEST)

Deep tests and high pressures found in the Gulf Coast (Louisiana and Texas) call for more precise reverse circulating procedures on casing tests. Surface pressures above 7500 psi have been encountered and wells below 15,000 ft. have been successfully tested and the recovered fluid reversed out.

While cased holes supply ideal reversing conditions by covering possible sloughing formations and allowing application of pressure in the annulus to speed the reversing process, the high formation pressures must be carefully guarded to prevent blow-outs. Both flow and reversing from these high pressure formations are controlled by 10,000 to 15,000 psi test flow heads.

The Type A Reversing Sub, Type B Reversing Sub and Shut-In Reversing Valves may be used equally well on casing tests. The shut-in reversing valve can be operated to take formation shut-in pressure and provide ports for reversing. These operations can be done separately or simultaneously—at the discretion of the oil company representative.

The practice of reversing from "bottom" and the "simultaneous" operation of the SIR valve is widely used.

Reversing sub or valve locations are dependent on the amount of "sample" to be left in the pipe. The "sample" attains even greater importance in cased holes because a small amount of salt water may indicate a cement "channel" job, which, if unnoticed, might lead to a work-over at a later date.

The SIR Valve can be operated without bleeding down the tubing or drill pipe pressure—an added feature which helps prevent tubing or drill pipe collapse.

If packer remains seated during reversing, pressure applied to the casing annulus will be blocked from the perforations tested.

The speed of reversing can be controlled by regulating the valves on the surface flow manifold and the pressure applied to the mud in the annulus below the closed rams or "Hydril."

By closely checking the weight (pounds per gallon or pounds per cubic foot) of the fluid being reversed out, a minimum of expensive drilling mud will be wasted. Normally reversing will be complete when clean mud of normal pit weight appears at the surface.

Reverse circulation check off list

Before operating reversing valve

- ☐ Pump running
- ☐ Mud line valves positioned to divert mud flow to annulus
- ☐ Rams and/or Hydril checked for operation

Operating Reversing Valve (Type A and/or Type B)

- ☐ Close well in at surface
- ☐ Disconnect high pressure steel flow hose
- ☐ Close shut-in tool by rotating
- ☐ Reconnect high pressure steel flow hose
- ☐ Bleed down drill pipe (if go-devil hanger not used)
- ☐ Check mud in annulus (*must stay full* throughout reversing operation). Packer may be pulled loose if shut-in period is completed.
- ☐ Drop proper go-devil to operate reversing sub
- ☐ Close surface valve (keep closed as long as annulus is *not* full)
- ☐ Control flow of recovery with surface valves so that hole remains full of mud.

Operating Shut-In Reversing Valve

- ☐ Close well in at surface
- ☐ Disconnect high pressure steel flow hose
- ☐ Check mud in annulus (mus stay full during shut-in an reversing procedure)
- ☐ Rotate to close SIR Valve fo shut-in (if valve is "blanked-off reversing may be started b further rotation, 11 rounds onl —if valve is not "blanked-off," do not rotate into reversing position)
- ☐ Rotate SIR Valve into reversing position (total of 11 rounds)
- ☐ Reconnect steel flow hose
- ☐ Keep surface valve closed as long as annulus is not full of mud
- ☐ Control flow of recovery with surface valves so that hole remains full of mud

NOTE: If reversing stops, apply moderate pressure to annulus or apply moderate pressure to tubing or drill pipe until normal circulation is barely established then go back to reverse circulation.

When natural reversing is completed or to speed reversing procedure

- ☐ Close rams or Hydril
- ☐ Apply moderate pump pressure to annulus
- ☐ Stop pumps when clean mud of normal weight is reversed
- ☐ Remove flow head and come out of hole at proper speed (prevent swabbing). Pipe should pull dry.

This is the second article on Reverse Circulating drill stem tests. The first article covered reverse circulation in the Permian Basin.

For complete information on Reverse Circulation write Johnston Testers, Houston, Texas.

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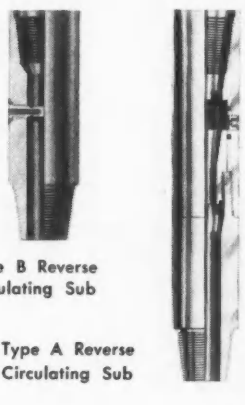

Type B Reverse Circulating Sub

Type A Reverse Circulating Sub

Shut-in Reversing Valve

JOHNSTON TESTERS

A Subsidiary of Schlumberger Well Surveying Corporation

first in drill stem testing

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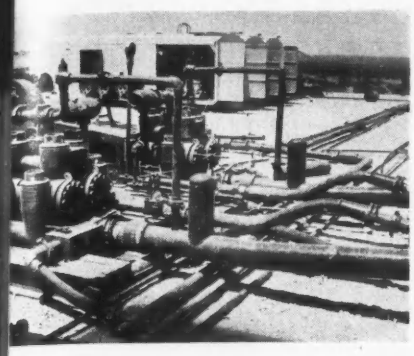
FORMATION AND CASING TESTING — JOHNSTON



Mud Pump Life Aided By Pulsation Dampener

One problem of the driller is pulsation in the mud lines. This simplified pulsation dampener on the intake line of the mud pumps has effectively dealt with this problem. This unit is little more than an air trap built from materials easily acquired. A short piece of pipe the same size as the intake line is saddle welded to the intake line, a short distance from pump suction line coupling. A disked head is welded on the top end of the short piece of pipe.

As the mud line is filled with mud, the air in the line is trapped in this chamber. The surging of the mud in the line causes the air trapped here to compress and expand according to the need of the line. The result is a more even flow of mud to the pumps. This smoother flow increases the pump valve life by cushioning the stresses caused by pulsation. This will result in a longer pump life.

Velocity Reducing Baffle Prevents Water Damage

Controlling run-off water in mountainous terrain is an expensive though necessary part of road-making and location work. One operator, to provide adequate but controlled run-off from one elevated road or location to the next one below it, prepares the conduiting in the manner shown in the photograph.

To prevent re-cutting of ground at the outfall end, a plate is welded across the open end of the pipe, and an equivalent or even larger net open area is cut out of the upper half of the pipe close to the end plate. Velocity of rainy season run-off water, rushing down hill for perhaps several hundred feet, is effectively slowed with such a baffle and without materially affecting the volume that otherwise might have been handled by the pipe.

Velocity of the upward-jetting water easily clears away sediment and trash that tends to collect in the small pocket near the end plate. Cost of preparing the pipe in this manner easily is repaid by the saving resulting from reduced repair work and grading that otherwise would be necessary at outfall ends.

DRILLMASTER 300 P.A. ROTARY DRILL

QUICKER DRILLING/ NO FLOODING/

The Drillmaster Power-Arm Drill represents an advanced approach to the truck/trailer mounted prospecting drill problem. The rotation of the drill pipe and bit is by means of motors mounted in a gear box at the upper end of the drill string. The rotary head, as this gear box is called, is moved up and down with the drill string by means of an arm which is pivoted at its front end.

The arm, and thus the rotary head which is mounted at the rear of the arm, is raised and lowered by jacks mounted a short distance to the rear of the arm front pivot point. In order that the rotary head shall travel up and down on a vertical straight line, a system of links is attached towards the front end of the arm, and to the front frame (about the top end of which the front end of the arm pivots); these links move the front pivot point of the arm forwards and rearwards thus maintaining the position of the rotary head above a fixed point. The system of links is a modified form of the well known "Scott-Russell" straight line motion and causes the rotary head to travel on a vertical straight line over the length of movement permitted by the jacks.

A guide mounted vertically under the rotary head, and a short distance above the ground, holds the first length of drill pipe, and the bit, vertically and prevents the turning bit from wandering at the commencement of the hole. As drilling progresses the guide serves to reduce whip in the drill string and so assists in maintaining the drilling of a straight hole. Send for illustrated bulletin.

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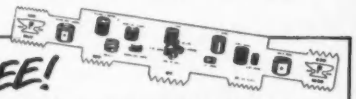
Anvil Brand Couplings start clean, run up fast because threads and chamfers are precision machined, gaged throughout manufacture, and electro-galvanized. Uniform wall thickness and properly aligned sealing surfaces provide dependable mechanical strength and full joints for trouble-free string service, minimum maintenance.

Anvil Brand Fittings—A.P.I. Couplings for all oil field applications, bushings, plugs, and nipples, are sold through your nearest supply store. Engineering service is always available from Anvil Brand Representatives in key oil country locations. Write for information.



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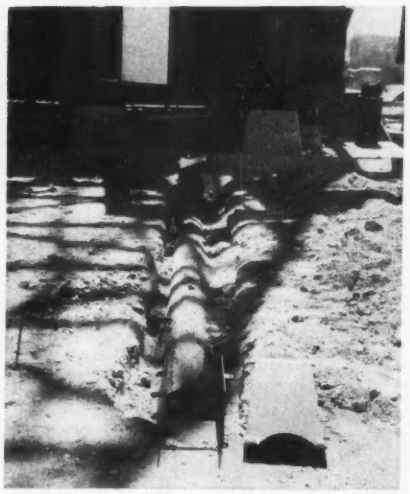
POCKET SIZE THREAD GAGE

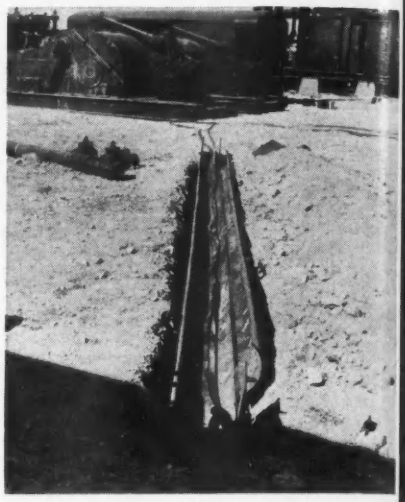
Identifies threads from 8 to 14 per inch, round or sharp, external or internal. Only 6¼" long. Write Oil Field Dept., Pittsburgh Pipe and Coupling Co., Allison Park, Pa.

ANVIL BRAND
forged seamless and wrought steel pipe fittings

PITTSBURGH
PIPE and COUPLING COMPANY
ALLISON PARK, PA., U.S.A.

Subsidiary: Anvil Products, Inc., Longview, Tex.
Affiliate: Canadian Coupling and Fittings, Ltd., Simcoe, Ont.



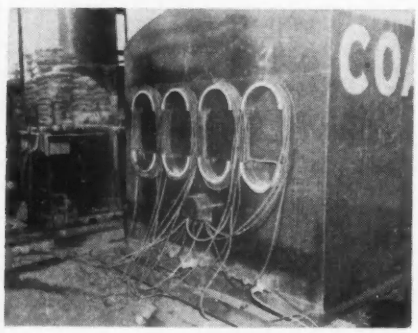


Protect Electric Cables With Split Pipe

One of the problems of the diesel-electric rig operator is the protection of the heavy cables necessary in this type of operation. Often the cables must cross the most traveled part of drilling area. Heavy traffic around rig may damage or destroy these cables.

One method of solving this problem is by using an old piece of pipe as casing across the traveled area. The pipe is split in half along its length and hinges welded on one of the cuts so the pipe can easily be opened or closed. Handles for opening or closing can be welded to the top half of the cut that opens. On each end of the pipe, a weld box is built to guide the cables into the casing and out of the ground. These boxes are built of plate and have a pinned down cover. The boxes are built tall enough to extend well above the ground and act as guides for the traffic to cross the installation.

To install the casing, a slip trench is dug long enough to take the casing and allow the guide boxes to bring the cable to the surface. The pipe is laid in the trench and opened and the cable strung inside the pipe. The pipe is then closed and covered with the dirt taken from the trench. The guide covers are put on, pinned down and the cables are ready for use. Traffic is guided across the casing by the boxes on each end. This not only protects the cables but protects the traffic from the cables as well.



Prevent Cable Damage With Permanent Racks

Excess electrical cable that often remains after rig lights and equipment are connected to the light plant frequently is vulnerable to damage by men or equipment tripping over it. Instead of piling it up wherever most convenient, or looping the coils over single pins or hooks, the latter practice often resulting in sharply bending or crushing of insulation, one operator provides inexpensive, always convenient racks which offer several distinct advantages.

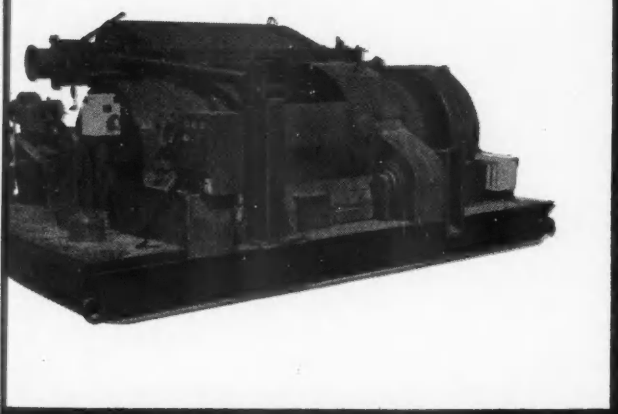
Immediately above the point where main cables emerge from the light plant house, are mounted four racks, each being a truck-size tire rim cut in half, spread apart and welded as shown. Attached so the fixed rim guard is on the outside, the units provide ideal storage for cable. There are no sharp corners or pins which might injure the insulation. Being adjacent to the point where cables emerge from the plant, the racks are a constant reminder to crewmen that cable should be picked up and protected.

U-1220-EB *electra-flow*

draw works

for greatest economy and smoothest performance...anywhere!

featuring 2 1/2" pitch triple extra heavy drum drive chain and single or split package



UNIT RIG EQUIPMENT CO. TULSA, OKLAHOMA U.S.A.

UNIT RIG & EQUIPMENT CO.

Export Sales: MID-CONTINENT SUPPLY CO.
45 Rockefeller Plaza, New York 20, N. Y.
Cable: MIDUNITRIG
Box 1889, Tulsa, Okla.

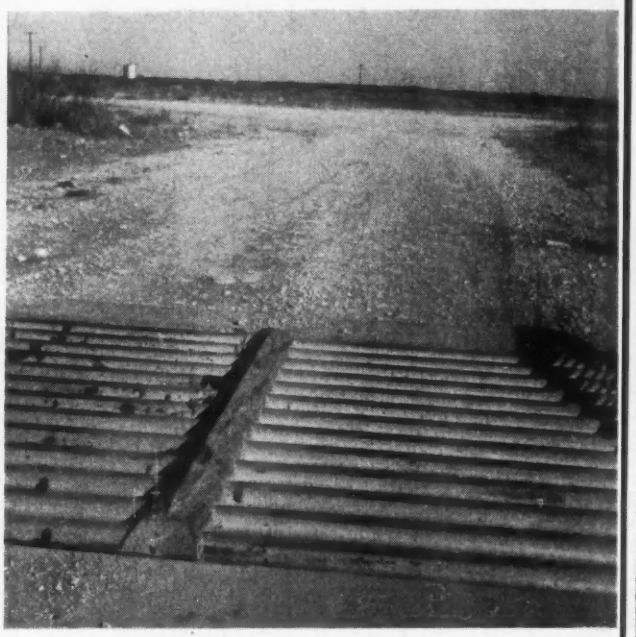
Unit Rig's Electra-Flow draw works — model U-1220-EB — in a single or split package — now offers the operator the widest application of the operating advantages of electric power for land or offshore drilling. Electric motors with rated horsepower of 1200 to 2000 are mounted as an integral part of the compact design. Dual input drive, coupled with high and low drum drives, provide four hoisting speeds. These speeds, coupled with the wide range of power and control of D.C. electric motors, give ideal performance characteristics. Two forward and two reverse speeds are available to the rotary, catshaft and optional sand line drum.

For maximum flexibility, greater operating economy, and trouble-free performance, ask your nearest Unit Rig representative about the U-1220-EB Electra-Flow draw works. Or write Unit Rig in Tulsa for new catalog.

PRODUCTION HINTS

These How-To-Do-It Ideas Can Save You Money

$10 is paid for each illustrated acceptable contribution. Mail to The Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas.



Weld Angle Iron to Center and End of Cattle Guard Sections

A tour of most any field will necessitate crossing cattle guards of many different types. The most adaptable type for field use is where the guard can be made up in the shop in compact sections, for hauling to the location. In this manner, it can be fitted into position on location, saving time and space when being hauled.

Cattle guards must necessarily be built of heavy structural members to withstand heavy truck and equipment loads and therefore often present little difficulty to animals wishing to cross the passage way. To prevent them from walking over the large O. D. transverse members, a piece of angle iron can be welded to the center of the member in a vertical position as shown in the photograph. This method of installation is simple but effective and offers no obstacle to the passage of vehicles.

Another interesting feature of this particular installation is the portable arrangement of the end sections. The end support frames can be removed from the base when transporting or when it is desirable to remove the guard in abandoning a lease or changing the entrance. Note that the angle iron welded on each end section serves the same purpose as that across the large member in the center of the guard. Pre-cut holes on each end of the section allow the two end guard rails to be bolted on without the aid of a welder.

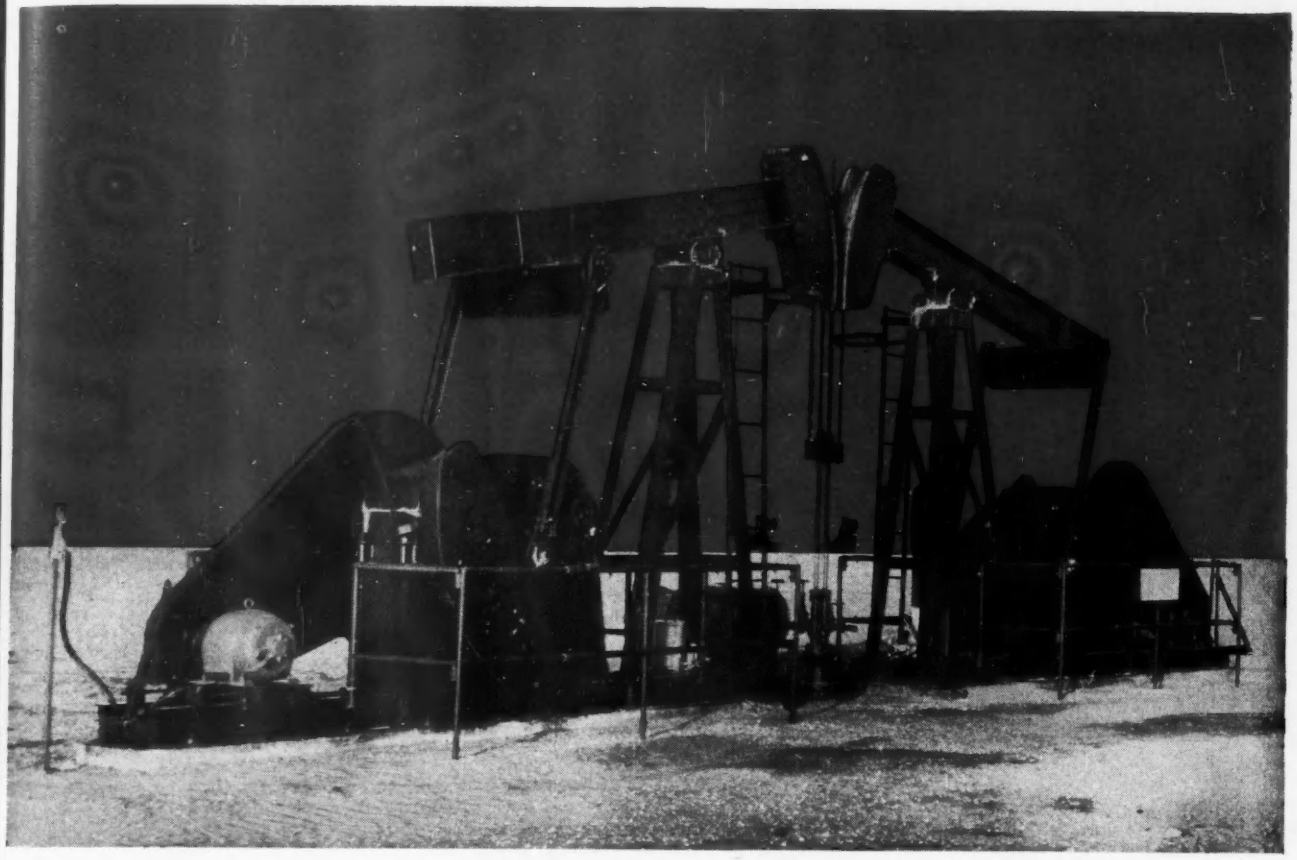
How-To-Do-It Ideas Earn Money, too!

WORLD OIL editors want how-to-do-it ideas, so your favorite short cut or invention could put money in your pocket! Write down the substance of your latest ideas and send them in with a picture or drawing of the installation . . . if accepted, $10 for each idea will be yours. Send those money-making ideas today to Hints Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas.

Make Sand, Water Trap From Seven-Inch Casing

Many types of sand and water traps for field installations have been made up in the shop and used to remove undesirable materials from the well-stream. In this case the well is producing dry gas directly into the sales line and required a trap for the removal

Did You Ever See a Double Headed Pump?



This unusual installation is operated by Low-Cost Utility Electric Power

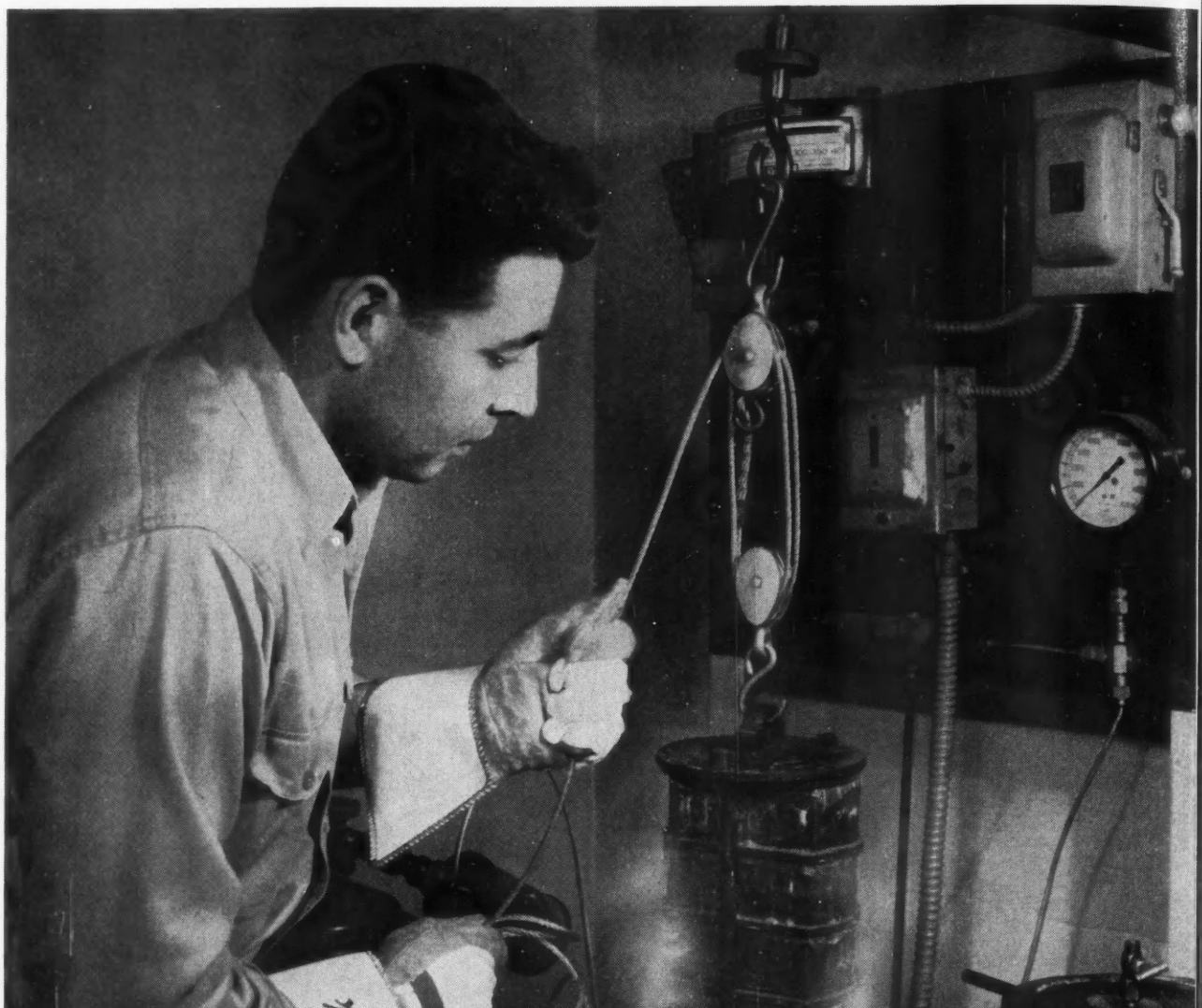
Pumping from different depths but through the same casing, these pumps can be operated simultaneously or singly. Each is operated by AUTOMATICALLY CONTROLLED push-button power – ELECTRIC POWER.

While such installations are not common, it is standard procedure in most fields today to utilize Utility Electric Power because of the overall LOWER COST, greater efficiency, and numerous special benefits.

For helpful counsel on how you can benefit, call the Power Engineer of your Utility Electric Service Company.

I'm LCP – Low-Cost Power
ON THE JOB – 24 HOURS DAILY.

PETROLEUM ELECTRIC POWER ASSOCIATION
P. O. BOX 35006 DALLAS, TEXAS



STRENGTH TESTS require special molds for cement specimens cured under high temperature and pressure in a pressure vessel. Here filled molds are being removed from the vessel at termination of curing period—one of many laboratory procedures insuring UNAFLO's consistent quality.

Constant testing of UNAFLO* oil-well cement means top performance in field

- Testing during manufacture pays off in down-the-well dependability of UNAFLO retarded oil-well cement.
- Slurries pump easily, stay fluid and pumpable under severe pressures and temperatures.
- UNAFLO's *retarded set* gives vital extra time in emergencies, yet slurries form a strong, watertight, sulphate-resistant seal.

For typical data tables, write: Universal Atlas, 100 Park Avenue, New York 17, N. Y.

UNIVERSAL ATLAS CEMENTS

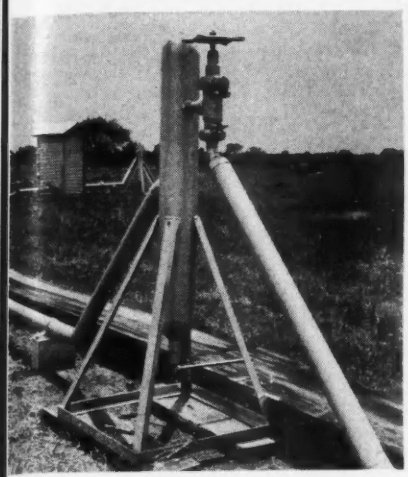
USS

* **"UNAFLO"** *is the registered trademark of the retarded oil-well cement manufactured by Universal Atlas Cement Company.*

U-152

UNIVERSAL ATLAS CEMENT COMPANY—member of the industrial family that serves the nation—**UNITED STATES STEEL**

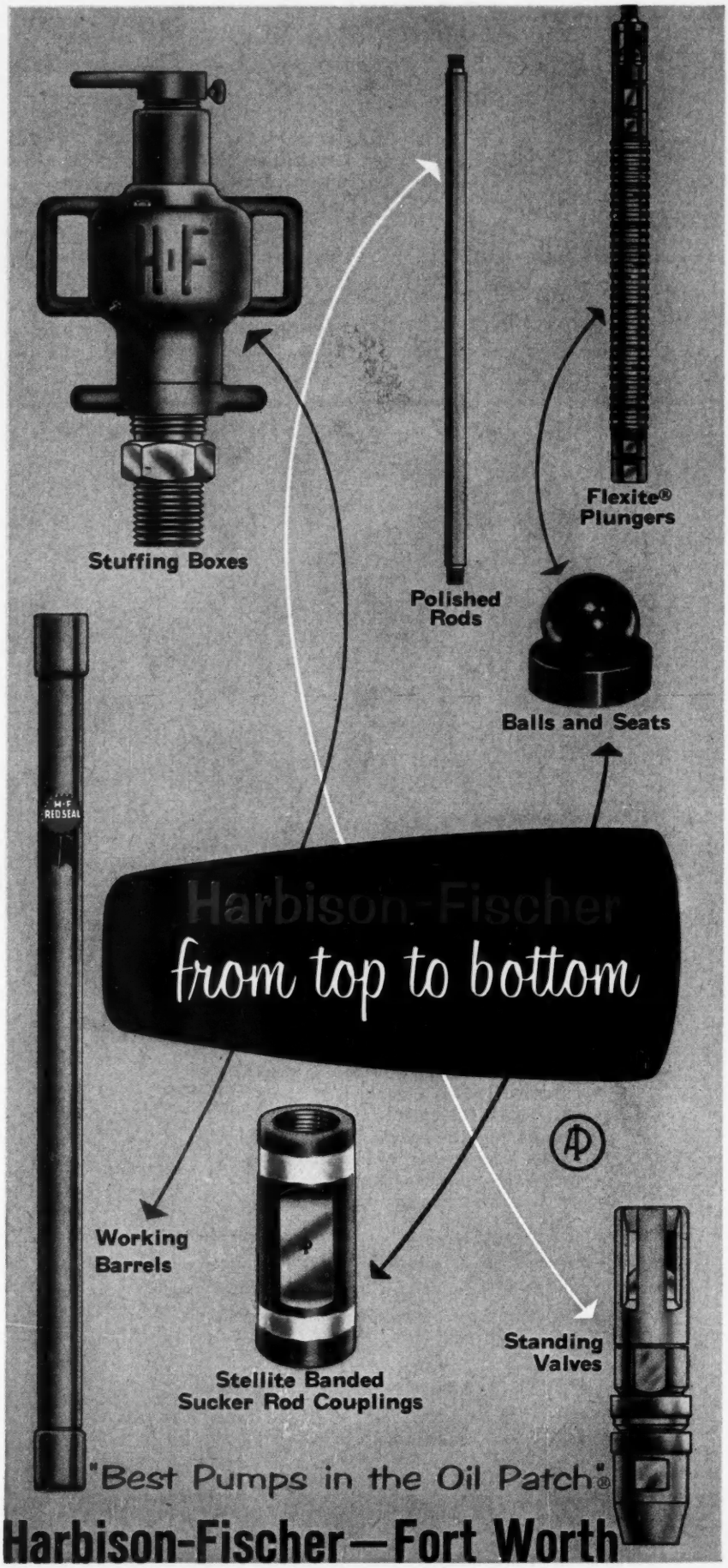
OFFICES: *Albany · Birmingham · Boston · Chicago · Dayton · Kansas City · Milwaukee · Minneapolis · New York · Philadelphia · Pittsburgh · St. Louis · Waco*



of water and sand. The installation, shown in the photograph, has worked satisfactorily for many years and was installed between the wellhead and the meter run directly in the flow line.

The trap was made from seven-inch casing, approximately five feet in length. The upper end was welded closed and a two-inch connection was welded in the bottom. This connection was fitted with a swedge, needle valve and one-half inch line, which served as the exhaust line for the removal of water and sand settling to the bottom of the trap. The wellstream enters the trap through a four-inch line, approximately 2½ feet from the top. Sand and water separate from the gas and settle to the bottom allowing the gas to flow through the adjustable choke, shown near the top to the right of the trap, and into the four-inch line to the meter run and sales line. The neat appearing installation is supported by angle iron framework as shown. The tops of four three-foot legs are welded to the outside of the casing and at the bottom to each inside corner of a rectangular base. Note that the flow line is supported above ground level by a concrete block and is clamped to the block to prevent vibration and surging from moving the line.

Once each tour the pumper can open the needle valve at the base of the trap allowing water and sand to be blown out. A board walk shown near the trap is designed to enable the pumper and other personnel to keep out of the water when tending to their duties as the installation lies in a low area, usually under water after heavy rains.



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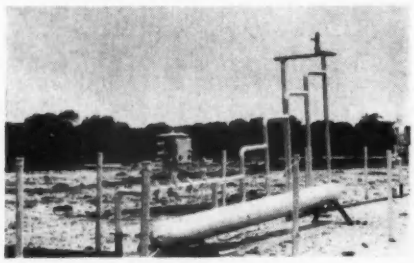


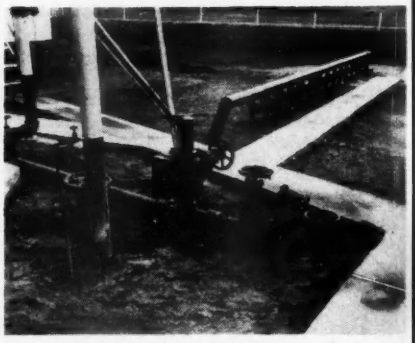
Shopmade Trap Serves As Water Knock-Out

An effective but economical means of separation for gas wells producing water but no distillate has been devised by one operator using a shop-made trap installed between the well-head and the meter run. The installation serves to separate out any solid material and liquid content from the wellstream prior to delivery into the sales lines.

As shown in the photograph, a piece of seven-inch casing can be made up in the shop for the trap. Legs are welded on the downstream side to support this end at a higher level. This allows gravity drainage of the removed liquid back to the upstream side. Six two-inch connections are welded into the top of the trap. Each end of the casing is orange-peeled and a one-inch connection is placed in the lower end for drainage.

Each two-inch connection of varied length, on top of the trap, is welded in position to make a step-up vertical system of piping as shown. Each vertical line is stepped-up approximately 10-12 inches from the preceding riser. A regulator is installed on the upstream side in the two-inch flow line. The two-inch discharge line is made-up with a valve for pressure bleed off, then dropped to ground level to tie-in to the meter run. A needle valve is provided in the trap input line to bleed-off pressure or to sample the well-stream before it enters the trap.

Gas and fluid entering the system are separated when encountering the vertical piping; gas goes over the top with any fluid failing to separate out into the next vertical line and so on. When the gas reaches the last vertical restriction, very little fluid is present. Once each tour, the pumper opens the one-inch drain line which empties any water or solid material from the trap.



Rod Welded to Cap Plug Gives Ease of Operation

Cap plugs are frequently used as a means of closing the chemical ball lubricator in the lease battery flow system. In order to facilitate the quick removal and replacement of this cap plug a rod approximately eight inches long is welded across the top of the cap to provide handles for turning.

The cap handle eliminates pipe wrenches usually necessary to remove and make up the plug even in low pressure systems. This simple tool saves the pumper valuable time both in the removal and making up the plug or in some instances making an-

7 Important Reasons Why JENSEN is a Better Buy

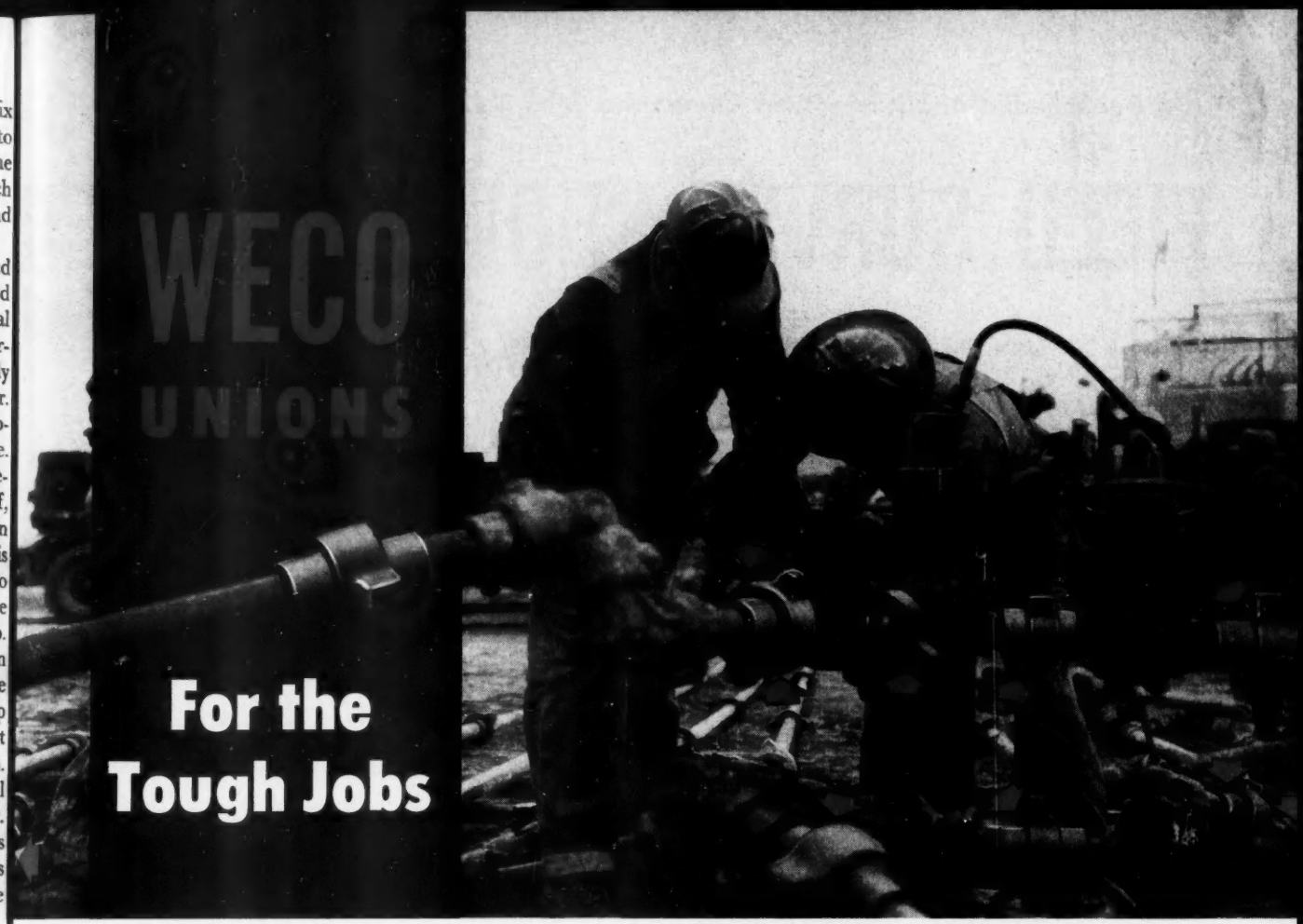
- ALL-WELDED CONSTRUCTION
- PRECISION SHAVED GEARS
- OIL BATH LUBRICATION
- DOUBLE TAPERED ROLLER-TYPE BEARINGS
- SINGLE and DOUBLE GEAR REDUCTIONS
- ONE-MAN COUNTERBALANCE
- 38 YEARS OF PROVED PERFORMANCE

Before you buy any jack, you'll want to consider these 7 important reasons that combine to afford better performance with a JENSEN JACK. Your JENSEN Dealer will be glad to show them to you. If you wish, visit any well equipped with a JENSEN—see this top performer in action!

STOCKED BY YOUR LOCAL SUPPLY STORE

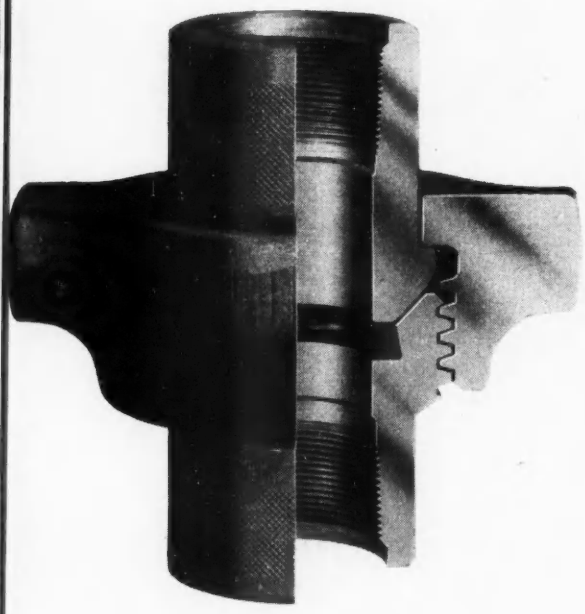
Made by JENSEN BROS. MFG. CO., INC., P. O. Box 477-D, Coffeyville, Kansas
Export Office: 60 East 42nd St., New York City, U.S.A.

JENSEN JACKS



For the Tough Jobs

WECO Fig. 1502 Unions (15,000 lb.) and Chiksan XHP Joints (15,000 lb.) in use on a fracturing job.



During the course of fracturing, cementing or acidizing operations, fittings and equipment are subjected to extremes of pressures, volumes and abrasion.

And that's when WECO's reputation for sealing and service has real meaning. Tough WECO Unions take the strain of the severest service as part of a regular day's work. Their famous ball and cone seat forms a metal-to-metal seal that refuses to leak under high pressures, shock, surge or vibrations. Their stronger subs and wing nuts, their heavier wall construction, and Acme threads take the toughest treatment as a matter of course on job after job.

It stands to reason: A union that can withstand the toughest service jobs can do a better job for you!

U-3-57

WECO®

WELL EQUIPMENT MFG. CORP.
HOUSTON, TEXAS

Division of CHIKSAN COMPANY *a subsidiary of*
FOOD MACHINERY AND CHEMICAL CORPORATION

PESA

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FOOD MACHINERY AND CHEMICAL CORPORATION

Just Published! "Analysis of 866 Cementing Jobs Using Cealment."

FIELD SURVEY SHOWS CEALMEN

Now—*proof from the field* that Cealment*, a Dowell-developed service using latex-cement, has been an important addition to the art of oil well cementing. During the period July 1, 1956 to June 30, 1957, Dowell performed 1,112 oil well cementing jobs in the United States using Cealment. A field study of these jobs, to determine the success-ratio of Dowell's latex-cement, has just been completed and published. Of the total jobs done, results were available on 866. And, of the 866, 656—or 76% were classified completely successful by the well owners or operators. A condensation of this field study is presented here for your information.

In Table I, all Cealment jobs are broken down into six types. Results are classified as: 1) Successful—where there was no doubt that Cealment performed as desired; 2) Partial Success—where latex-cement did not achieve the full measure of success desired, but did improve the overall condition of the well; and 3) Unsuccessful—where the material failed to perform as desired. *Job success-ratio is based on jobs classified as completely successful only.*

TABLE I

(In this survey a job is defined as a single application.)

APPLICATION	NUMBER OF JOBS	SUCCESSFUL	PARTIAL SUCCESS	UNSUCCESSFUL	SUCCESS RATIO
1. Squeeze	389	257	27	105	66.1%
2. Tail-In	273	255	5	13	93.4%
3. Liner	30	27	0	3	90.0%
4. Plug-Back	143	89	10	44	62.3%
5. Primary Cementing	22	21	0	1	95.5%
6. Lost Circulation	9	7	0	2	77.8%

ENUCCESSFUL IN 76% OF ALL JOBS

SQUEEZE JOBS—66.1% SUCCESSFUL

MOST OF THESE JOBS WERE PERFORMED ON ZONES IN WHICH REGULAR CEMENT SQUEEZE JOBS HAD FAILED. One major oil company reported that where they were using Cealment, the first stage was successful—but when using regular portland two, three, or more stages were required. This comparison is based on squeeze jobs where *identical application techniques were used for both regular portland cement and latex-cement.*

TAIL-IN JOBS—93.4% SUCCESSFUL

NEARLY ALL OF THESE JOBS WERE COMPLETED IN AREAS NOTED FOR SERIOUS COMMUNICATION PROBLEMS. The 93.4 per cent success-ratio reveals the high proficiency of Dowell latex-cement in preventing communication between closely-spaced zones.

An operator in Stonewall County, Texas attests the effectiveness of Cealment, ". . . we tried tailing-in with Cealment, covering the producing sections with Dowell latex-cement. We then perforated the zones and fractured between straddle packers to isolate each zone. On the 15 to 20 jobs completed to date using this method, we have had no communication trouble. We have been able to segregate perforations as close as eight feet with Cealment. We have used portland on 60 to 70 wells and were never able to segregate perforations closer than 18 feet."

LINER JOBS—90.0% SUCCESSFUL

THESE JOBS ARE ADDITIONAL EVIDENCE OF THE VERSATILITY OF DOWELL LATEX-CEMENT. The number of jobs for this application is not large. However, the success-ratio shows that Cealment is especially suited to insuring the success of well completions.

PLUG-BACK—62.3% SUCCESSFUL

TOO LITTLE LATEX-CEMENT LISTED AS CAUSE OF MOST FAILURES. JOBS WERE PERFORMED WITH DUMP BAILERS. A more accurate analysis of the point of water entry would have increased the success-ratio. In most cases, a second stage achieved success.

PRIMARY CEMENTING—95.0% SUCCESSFUL

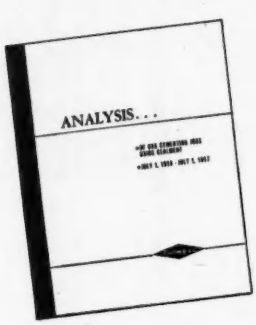
CEALMENT CAN BE USED IN ANY TYPE OF CEMENTING JOB. These 22 applications represent jobs where latex-cement was used to set the entire casing string. Of these 22 jobs only one was classified as unsuccessful.

LOST CIRCULATION—77.8% SUCCESSFUL

SMALL NUMBER OF JOBS, BUT SIGNIFICANT IN DEMONSTRATING THE VALUE OF LATEX-CEMENT IN PREVENTING LOST CIRCULATION. Because of the specific problem of these jobs no direct comparison with other cementing methods can be made.

The slurry used in Cealment is a mixture of cement, liquid-latex and a special surface active agent. It overcomes most of the disadvantages of common portland cement. Dependable field performance under the most difficult conditions has proved the value of Dowell's latex-cement for the past two years. Its superior bonding strength, its high resiliency for perforating, and its resistance to contamination by mud make the latex-cement slurry especially suited for the critical area of your well.

For more information on Cealment—the most effective cementing service in the oil industry—or for service call the Dowell station nearest you.



For your personal copy of the "Analysis of 866 Cementing Jobs Using Cealment" write Dowell Incorporated, Box 536, Tulsa, Oklahoma. Or see your Dowell representative.

*Service Mark of Dowell Incorporated

Services for the oil industry

DOWELL

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY

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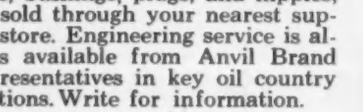

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forged seamless and wrought steel pipe fittings

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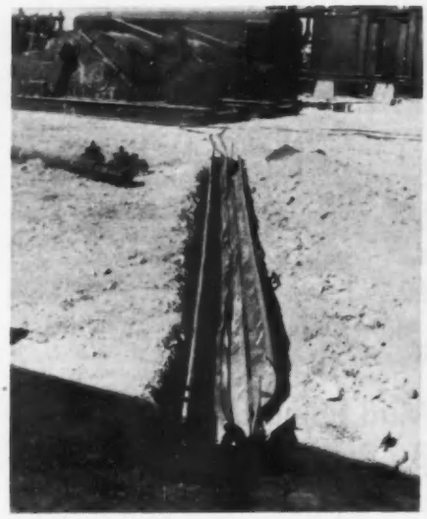

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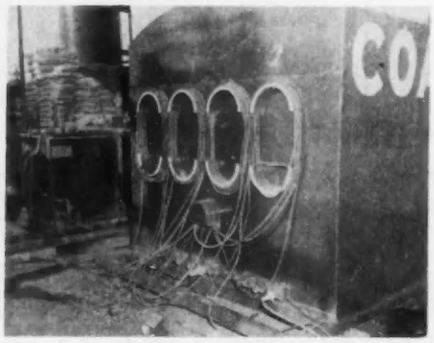
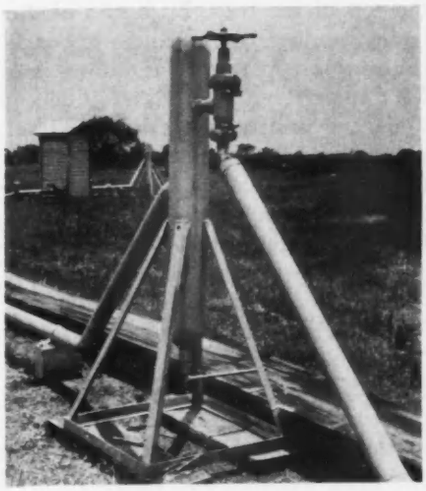


Prevent Cable Damage With Permanent Racks

Excess electrical cable that often remains after rig lights and equipment are connected to the light plant frequently is vulnerable to damage by men or equipment tripping over it. Instead of piling it up wherever most convenient, or looping the coils over single pins or hooks, the latter practice often resulting in sharply bending or crushing of insulation, one operator provides inexpensive, always convenient racks which offer several distinct advantages.

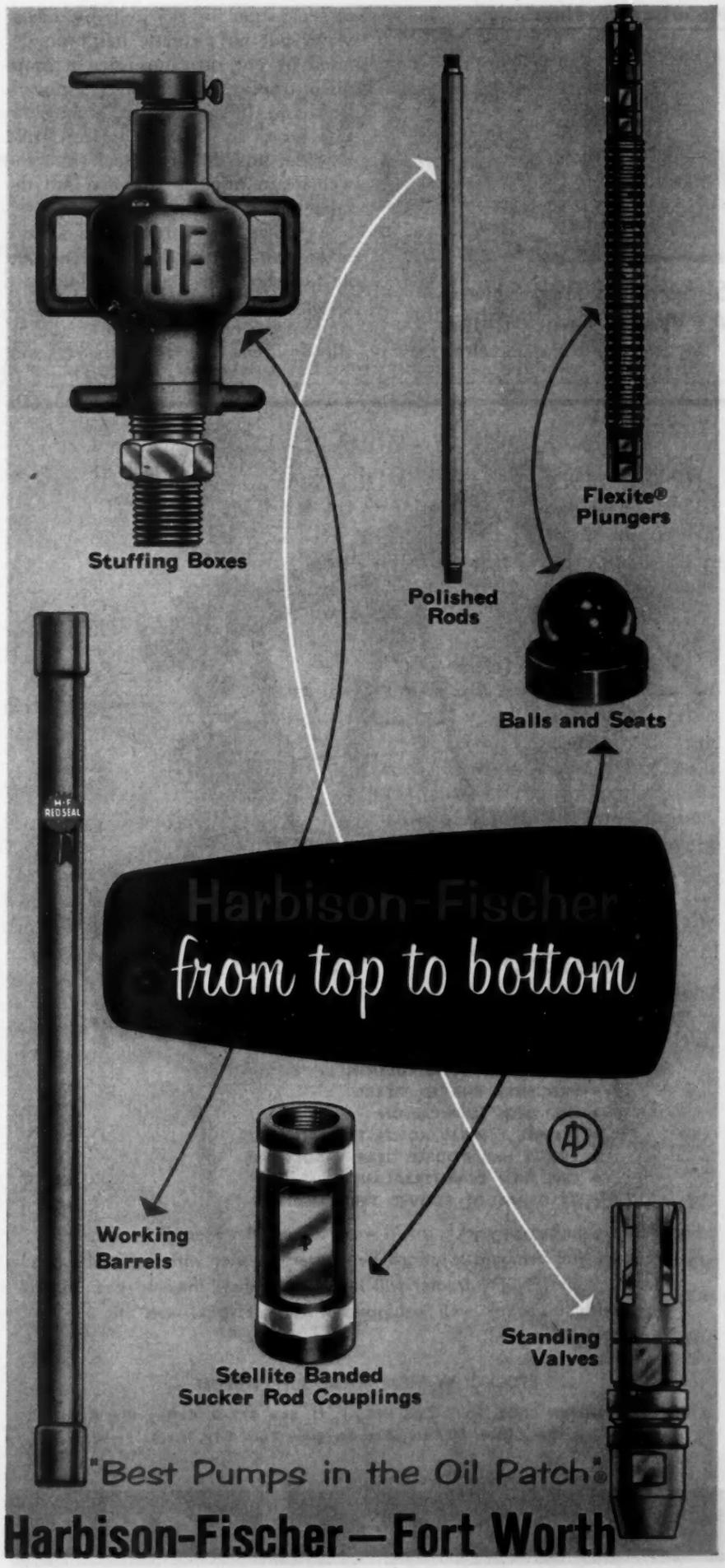
Immediately above the point where main cables emerge from the light plant house, are mounted four racks, each being a truck-size tire rim cut in half, spread apart and welded as shown. Attached so the fixed rim guard is on the outside, the units provide ideal storage for cable. There are no sharp corners or pins which might injure the insulation. Being adjacent to the point where cables emerge from the plant, the racks are a constant reminder to crewmen that cable should be picked up and protected.



of water and sand. The installation, shown in the photograph, has worked satisfactorily for many years and was installed between the wellhead and the meter run directly in the flow line.

The trap was made from seven-inch casing, approximately five feet in length. The upper end was welded closed and a two-inch connection was welded in the bottom. This connection was fitted with a swedge, needle valve and one-half inch line, which served as the exhaust line for the removal of water and sand settling to the bottom of the trap. The wellstream enters the trap through a four-inch line, approximately 2½ feet from the top. Sand and water separate from the gas and settle to the bottom allowing the gas to flow through the adjustable choke, shown near the top to the right of the trap, and into the four-inch line to the meter run and sales line. The neat appearing installation is supported by angle iron framework as shown. The tops of four three-foot legs are welded to the outside of the casing and at the bottom to each inside corner of a rectangular base. Note that the flow line is supported above ground level by a concrete block and is clamped to the block to prevent vibration and surging from moving the line.

Once each tour the pumper can open the needle valve at the base of the trap allowing water and sand to be blown out. A board walk shown near the trap is designed to enable the pumper and other personnel to keep out of the water when tending to their duties as the installation lies in a low area, usually under water after heavy rains.



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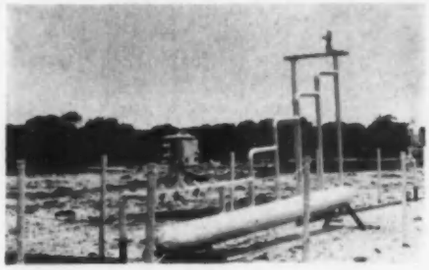


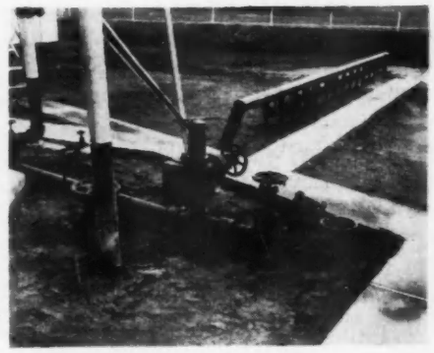
Shopmade Trap Serves As Water Knock-Out

An effective but economical means of separation for gas wells producing water but no distillate has been devised by one operator using a shopmade trap installed between the wellhead and the meter run. The installation serves to separate out any solid material and liquid content from the wellstream prior to delivery into the sales lines.

As shown in the photograph, a piece of seven-inch casing can be made up in the shop for the trap. Legs are welded on the downstream side to support this end at a higher level. This allows gravity drainage of the removed liquid back to the upstream side. Six two-inch connections are welded into the top of the trap. Each end of the casing is orange-peeled and a one-inch connection is placed in the lower end for drainage.

Each two-inch connection of varied length, on top of the trap, is welded in position to make a step-up vertical system of piping as shown. Each vertical line is stepped-up approximately 10-12 inches from the preceding riser. A regulator is installed on the upstream side in the two-inch flow line. The two-inch discharge line is made-up with a valve for pressure bleed off, then dropped to ground level to tie-in to the meter run. A needle valve is provided in the trap input line to bleed-off pressure or to sample the well-stream before it enters the trap.

Gas and fluid entering the system are separated when encountering the vertical piping; gas goes over the top with any fluid failing to separate out into the next vertical line and so on. When the gas reaches the last vertical restriction, very little fluid is present. Once each tour, the pumper opens the one-inch drain line which empties any water or solid material from the trap.



Rod Welded to Cap Plug Gives Ease of Operation

Cap plugs are frequently used as a means of closing the chemical ball lubricator in the lease battery flow system. In order to facilitate the quick removal and replacement of this cap plug a rod approximately eight inches long is welded across the top of the cap to provide handles for turning.

The cap handle eliminates pipe wrenches usually necessary to remove and make up the plug even in low pressure systems. This simple tool saves the pumper valuable time both in the removal and making up the plug or in some instances making an-

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SQUEEZE JOBS — 66.1% SUCCESSFUL

MOST OF THESE JOBS WERE PERFORMED ON ZONES IN WHICH REGULAR CEMENT SQUEEZE JOBS HAD FAILED. One major oil company reported that where they were using Cealment, the first stage was successful—but when using regular portland two, three, or more stages were required. This comparison is based on squeeze jobs where *identical application techniques were used for both regular portland cement and latex-cement.*

TAIL-IN JOBS — 93.4% SUCCESSFUL

NEARLY ALL OF THESE JOBS WERE COMPLETED IN AREAS NOTED FOR SERIOUS COMMUNICATION PROBLEMS. The 93.4 per cent success-ratio reveals the high proficiency of Dowell latex-cement in preventing communication between closely-spaced zones.

An operator in Stonewall County, Texas attests the effectiveness of Cealment, ". . . we tried tailing-in with Cealment, covering the producing sections with Dowell latex-cement. We then perforated the zones and fractured between straddle packers to isolate each zone. On the 15 to 20 jobs completed to date using this method, we have had no communication trouble. We have been able to segregate perforations as close as eight feet with Cealment. We have used portland on 60 to 70 wells and were never able to segregate perforations closer than 18 feet."

LINER JOBS — 90.0% SUCCESSFUL

THESE JOBS ARE ADDITIONAL EVIDENCE OF THE VERSATILITY OF DOWELL LATEX-CEMENT. The number of jobs for this application is not large. However, the success-ratio shows that Cealment is especially suited to insuring the success of well completions.

PLUG-BACK — 62.3% SUCCESSFUL

TOO LITTLE LATEX-CEMENT LISTED AS CAUSE OF MOST FAILURES. JOBS WERE PERFORMED WITH DUMP BAILERS. A more accurate analysis of the point of water entry would have increased the success-ratio. In most cases, a second stage achieved success.

PRIMARY CEMENTING — 95.0% SUCCESSFUL

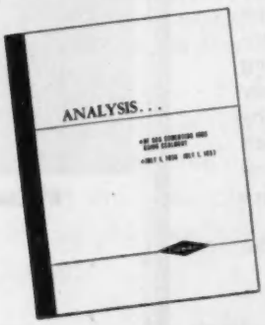
CEALMENT CAN BE USED IN ANY TYPE OF CEMENTING JOB. These 22 applications represent jobs where latex-cement was used to set the entire casing string. Of these 22 jobs only one was classified as unsuccessful.

LOST CIRCULATION — 77.8% SUCCESSFUL

SMALL NUMBER OF JOBS, BUT SIGNIFICANT IN DEMONSTRATING THE VALUE OF LATEX-CEMENT IN PREVENTING LOST CIRCULATION. Because of the specific problem of these jobs no direct comparison with other cementing methods can be made.

The slurry used in Cealment is a mixture of cement, liquid-latex and a special surface active agent. It overcomes most of the disadvantages of common portland cement. Dependable field performance under the most difficult conditions has proved the value of Dowell's latex-cement for the past two years. Its superior bonding strength, its high resiliency for perforating, and its resistance to contamination by mud make the latex-cement slurry especially suited for the critical area of your well.

For more information on Cealment—the most effective cementing service in the oil industry—or for service call the Dowell station nearest you.



For your personal copy of the "Analysis of 866 Cementing Jobs Using Cealment" write Dowell Incorporated, Box 536, Tulsa, Oklahoma. Or see your Dowell representative.

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other trip after forgetting his wrench.

A system shown in the picture is used by one company to minimize corrosion costs by placing water soluble chemical balls into the vertical four-inch nipple. The balls fall through the open valve into the four-inch line at ground level carrying water and oil from the separator into the gun barrel and go into solution with this fluid. The valve to the right of the vertical input chemical line is closed and the balls remain in the short section of the four-inch line. When in solution, the chemical inhibitor is carried with water and crude from the low pressure separator over into the gun barrel or directly into the heater and then to the gun barrel, as the case may be.

The four-inch vertical line, shown with the one-half inch line, is the gas line returning from the low pressure separator. The horizontal four-inch line going into the ground to the right of the chemical input line is tied-in to the test separator. The valve behind the four-inch vertical gas line is on the input line from the manifold to low pressure separator.

Solvent Container Holder Built on Centrifuge Stand

Pumpers are required to sample crude or distillate to determine percentage basic sediment and water and are constantly using a centrifuge at some place around the lease or pumpers shack.

The stand illustrated in the picture serves as a permanent, stable mount for the centrifuge as well as providing a holder for the sample of fluid or solvent required to obtain the total "cut." Placing the solvent or sample container on top of the stand or table where the centrifuge is mounted often results in breakage of the container or spilling of the solvent or liquid sample. It is desirable to have the centrifuge mounted on a stable platform with a definite, convenient place for keeping the solvent or liquid sample container.

The stand is made of a one-half inch steel plate welded to the top of a four-foot length of two-inch line pipe imbedded below ground level in concrete. The holder can be made from a short piece of two-inch pipe or a scrap coupling with the base welded from a scrap piece of metal plate. The centrifuge is clamped to the top metal plate.

Mounted in a convenient spot, this installation will prove satisfactory and save the pumper many steps.

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Save time and trips by installing an Enardo Clock Shut-Off Valve.

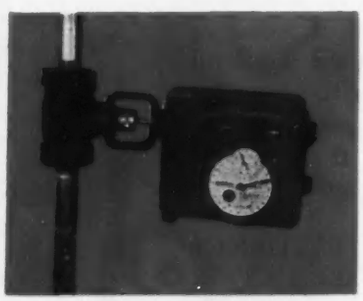
You can soon pay the initial cost of installing the Enardo Clock by saving the return trips necessary to check installations.

The Model "W" Clock is designed to control the flow of low pressure gas or liquid and to shut off the supply at a predetermined time, with a positive bottle tight seal. Valve will function at operating pressures up to 100 p.s.i.

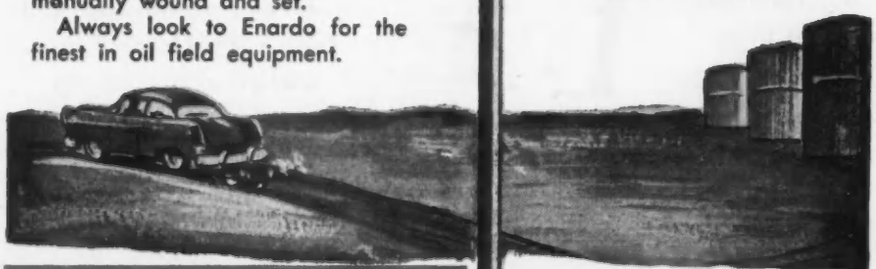
The Enardo "MB" and "A" time cycle switches are designed to control electrical circuits on pumping engines and other equipment. They will shut-down the engine at any number of hours, up to 22 hrs. on the 24 hr. model; and 11 hrs. on the 12 hr. model. All clocks are manually wound and set.

Always look to Enardo for the finest in oil field equipment.

"A" & MB Type Time Cycle Switch



"W" Clock Shut-Off Valve



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That's why you'll find Wagner Unit Substation Transformers at work at the Carter Oil Company refinery at Billings, Montana.

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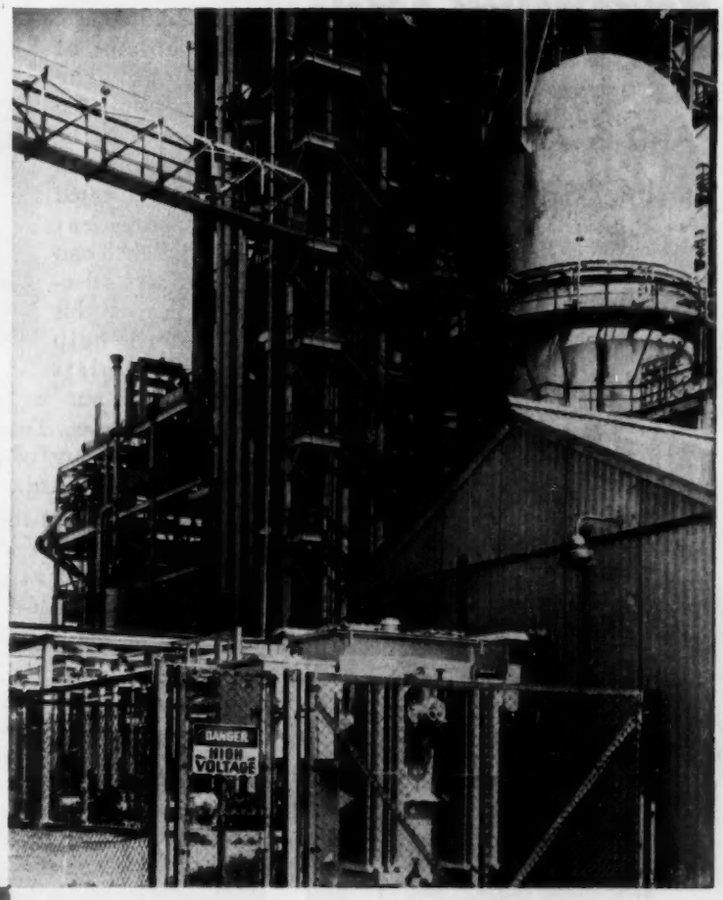

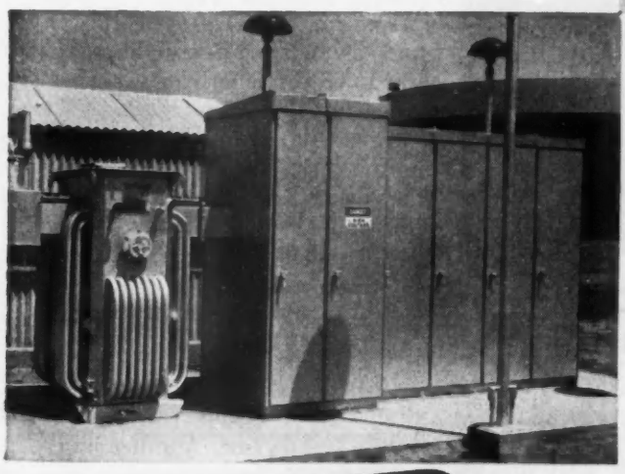

The 750 kva, 2400/4160Y to 480 volt, 60 cycle, three-phase, liquid-filled Wagner Unit Substation Transformer feeds the catalytic unit at The Carter Oil Company refinery. At left is shown a 225 kva Wagner substation transformer connected to an outdoor substation at the same refinery. Purchased and installed by The Fluor Corporation, Ltd., Engineers and Constructors for the Petroleum, Chemical and Power Industries, Los Angeles.

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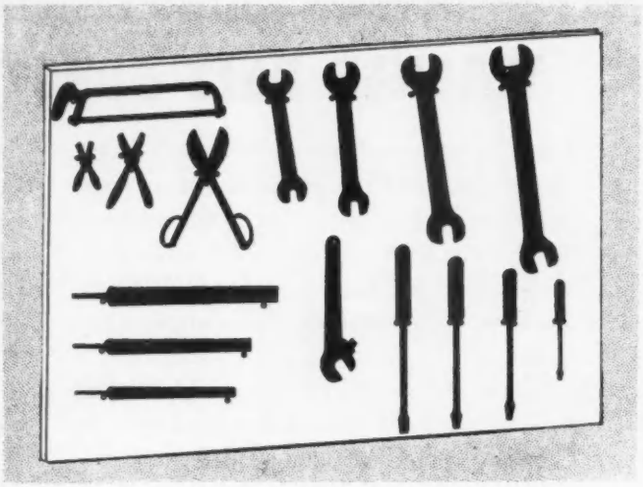
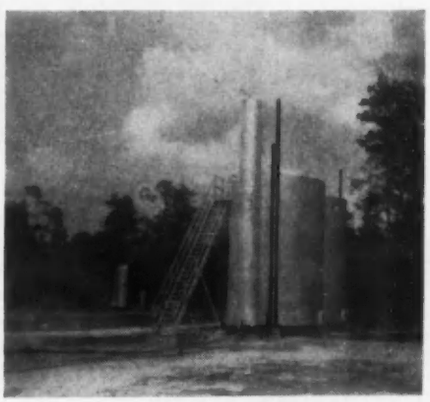
Outlined Tool Board Facilitates Selection



With the multiplicity of tools necessary for communications work shop maintenance, the problem of picking up the right tool for the right job can be time-consuming. A tool board located on the wall near the work bench can speed up tool selection. However, this board will help very little, unless all tools are put in their assigned places after use. To facilitate the proper replacement of tools, prepare this simple tool board.

Hang the tools on the board in the desired arrangement. With the tools hanging in their natural positions, outline with pencil each tool on the board. Remove the tools and paint inside each outline with a color contrasting to the base color of the tool board.

The board will show at a glance the assigned place for any tool missing or being used.



Use Conductor Casing In Making Gun Barrel

Shown in the photograph is a piece of 20-inch conductor casing made into a gun barrel for use on a one well lease with a gas well making water and distillate. Fluid from the low pressure separator flows through a heater and then into the top of the gun barrel. The distillate separates out from the salt water and goes over into the stock tank while the water is siphoned in the conventional manner from the bottom of the casing.

A gun barrel of this type can be made up in the shop and fitted with connections on location in the field. Fluid enters through a one-inch line tied-in to the flume at the top. The flume, made of two-inch pipe, is placed in the center of the casing and extends approximately two-thirds of the length to near bottom. Any fluid entering the gun barrel must break through the water in the bottom; the distillate separates out and water remains at the lower level for siphoning to the salt water disposal system. The base of the tank is placed on top of a concrete slab. Scrap steel rods are spot welded into place for a ladder on one side as shown. The base is fitted with a water discharge line and valve connected to the siphon line. Another base outlet is fitted with a line and valve for draining or pumping off the bottom.

This installation was a simple, inexpensive but effective means to achieve fluid separation for a gas well producing distillate with water of insufficient volume to necessitate a water knock-out or larger gun barrel.

What's Happening among MEN in the INDUSTRY

L. F. Ivanhoe has opened offices in Bakersfield, Calif., as a consulting geologist and geophysicist in petroleum exploration. The services offered by him are organization and supervision of exploration programs, review and interpretation of geological and geophysical data, and the examination and evaluation of oil, gas and mineral lands. Ivanhoe was previously with Franco Western Oil Co. for three years.

•

James Edward Harrison has assumed the newly-created position of district geophysicist of **Pan American Petroleum Corporation's** East Texas district, headquartered in Tyler, Texas. Harrison has been with Pan American since 1950, and has held various geophysical positions in the North Texas-New Mexico and Texas-Louisiana Gulf Coast divisions. Prior to his promotion, Harrison was staff geophysicist in Pan American's New Orleans office.

•

C. A. Wischoff, Shell Oil Company, has been named production superintendent of the new created Amarillo, Texas, district. Formerly he was production superintendent of the Elk City, Okla., district, and has worked as exploitation engineer in the North Texas division.

•

O. F. Van Beveren was elected vice president and director of **Standard Oil Company of California, Western Operations, Inc.,** and named general manager of the company's Exploration department. He was appointed manager of exploration in 1952 and temporarily assigned as special consultant in 1956. In his new capacity, he will have responsibility for conducting the company's exploratory activities in the seven Western states and Alaska.

O. F. Van Beveren

•

J. O. DeLancey was appointed secretary-treasurer of **The California Oil Company.** In his new position DeLancey replaces **F. W. Mayer** who retired. Office manager for the Barber Asphalt Company at the time of its consolidation with The California Company in 1946, DeLancey has been manager-personnel and labor relations for Caloil since 1952 when that department was organized.

Robert O. Garrett

James W. O'Keefe

Robert O. Garrett, vice president and general manager of **Texas Gas Exploration Corp.,** Houston, has been elected to the company's board of directors. Election of **James W. O'Keefe** as treasurer of the exploration corporation, and appointment of **W. J. Wooton** as manager of its Land department, were announced at the same time. Garrett, a veteran of 31 years in the oil and gas business, has been associated with Texas Gas Exploration since 1955.

W. J. Wooten

•

O. W. (Buzz) Fauntleroy has resigned his position as geologist with R. Clay Underwood and has opened his offices as a consulting geologist in the Robertson building, Wichita Falls, Texas. He was formerly with Stanolind Oil and Gas Co., the J. M. Huber Corporation, Wm. Ross Cabeen and Associates and Bolin Oil Co.

•

Chadwick H. Carpenter has been appointed to the newly created post of executive assistant to the president of **Standard Oil Company (New Jersey).** Carpenter, who began his career with Jersey in 1937, was formerly secretary of the Executive committee and assistant secretary of the Jersey company. In 1946, he joined the secretary's office where he was later made a management assistant and in 1950 was appointed assistant secretary of the Executive Committee and of the company.

•

Jess. L. Warren was appointed secretary-treasurer of **Shelton-Warren Oil Company.** He will direct a major part of the company's exploitation of oil properties in this state and in the western part of Texas. In 1953 Warren opened his own office in Abilene as an independent geologist and

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acquired leases and oil production in West Central Texas. His first association with **Bill A. Shelton** came last year when he joined the Shelro Drilling Company at Lovington, N. M., as general manager. Earlier this year he and Shelton formed a partnership and from this evolved long-range plans that have been consolidated with the founding of the Shelton-Warren Oil Co.

•

Carl G. Drescher

F. A. Bush

F. A. Bush and **Carl G. Drescher** were elected vice presidents of **Sinclair Oil Corporation.** The two new officers will be executive assistants to the executive vice president for operations, E. L. Steiniger. Bush will be concerned primarily with crude oil production and research, and Drescher with foreign operations, exclusive of Venezuela, and with the purchase and sale of foreign crude oil. Bush also is a vice president and director of Sinclair Oil & Gas Company and has been chief geologist of the Sinclair organization since 1930. He also is a director of Sinclair Research Laboratories, Inc. Drescher has been assistant director for foreign operations, exclusive of Venezuela. He joined the company in September, 1956, upon his retirement as a Rear Admiral, U. S. Navy.

•

William O. Brown of **Humble Oil & Refining Company** has had a report selected by the Society of Petroleum Engineers as the best technical paper of the year by a junior member of the organization. Brown, who is a research engineer at the Houston Research Center, was awarded the Cedric K. Ferguson Medal for his achievement at the fall meeting of the Society of Petroleum Engineers last October. The paper is a report on a laboratory investigation of the mobility of connate water during the waterflooding of an oil well. Brown has been an employe of Humble since 1954.

William O. Brown

•

Kerr-McGee Oil Industries, Inc., has made a number of changes in its Exploration department. **Harold J. Kleen** assumes the duties of the newly created position of manager of Land, Geological and Geophysical departments. Kleen, formerly chief geologist, continues to report to **J. C. Finley**, vice president in charge of exploration. **Walter Marlin** becomes Finley's special assistant. Department heads reporting to Kleen are: **L. W. Curtis**, who is regional geological manager in charge of the Central division (Oklahoma-Kansas-North Texas), the Rocky Mountain division and the Panhandle district; **J. A. Masters**, who is regional geological manager in charge of the Southern division, the West Texas-New Mexico division, and the Canadian division; and **D. L. Amonett**, who becomes chief geophysicist.

Replacing Masters as divisional geological manager of the Canadian division, with offices in Calgary, Alberta, is **R. L. Duncan.** The other divisional geological managers are **R. B. Capps**, Southern division, and **P. R. Becker**, West Texas-New Mexico division, **S. G. Hardison** is district geologist of the enlarged Panhandle district, with offices at Amarillo. **D. L. Brown** and **J. C. Meyer** are district geologists of the enlarged Rocky Mountain division, with offices in Denver.

•

William Hill, Jr., vice president of Dillon, Reed and Co., New York, has been elected to the board of directors of **Falcon Seaboard Drilling Co.**, Tulsa. Hill has been with the New York Financial house since 1926, except for the years 1942 to 1946 when he served on the board of Navy Price Adjustment in Washington. Hill was active in the planning of Falcon's first public offering of $3,500,000, handled by Dillon, Reed and Co. last April, which was completely subscribed the first day.

•

Elmer F. Blake has rejoined **Southern Geophysical Company** as vice president in charge of Rocky Mountain operations with headquarters in Denver. Blake will direct all Southern seismic, gravity and core drilling activities in the area. Blake was previously with Southern for five years before resigning in 1954 to enter business for himself as consulting geophysicist, seismic and core drilling contractor of Denver and Grand Junction, Colo.

Elmer F. Blake

•

Robert P. Evans was elected vice president and a director of **Kin-Ark Oil Company** of El Dorado, Ark. Evans joined Kin-Ark after 11 years with Lion Oil Company during which time he was named manager of the firm's Central Region in Wichita, Kansas, where he directed Lion's land, geological and production programs. He also was active in a number of other Lion operations in Bismarck, N. D.; Billings, Mont.; Midland, Texas, and El Dorado. Prior to joining Lion in 1946, Evans was affiliated with Magnolia Petroleum Company in Oklahoma City.

•

Robert E. Rettger was named assistant division chief geologist-technical and **Wallace Ralston** assistant division chief geologist-operational for **Sun Oil Company's** Southwest Production division at Dallas. In their new posts, Ralston and Rettger will assist division chief geologist **Francis E. Heath** in planning and admin-

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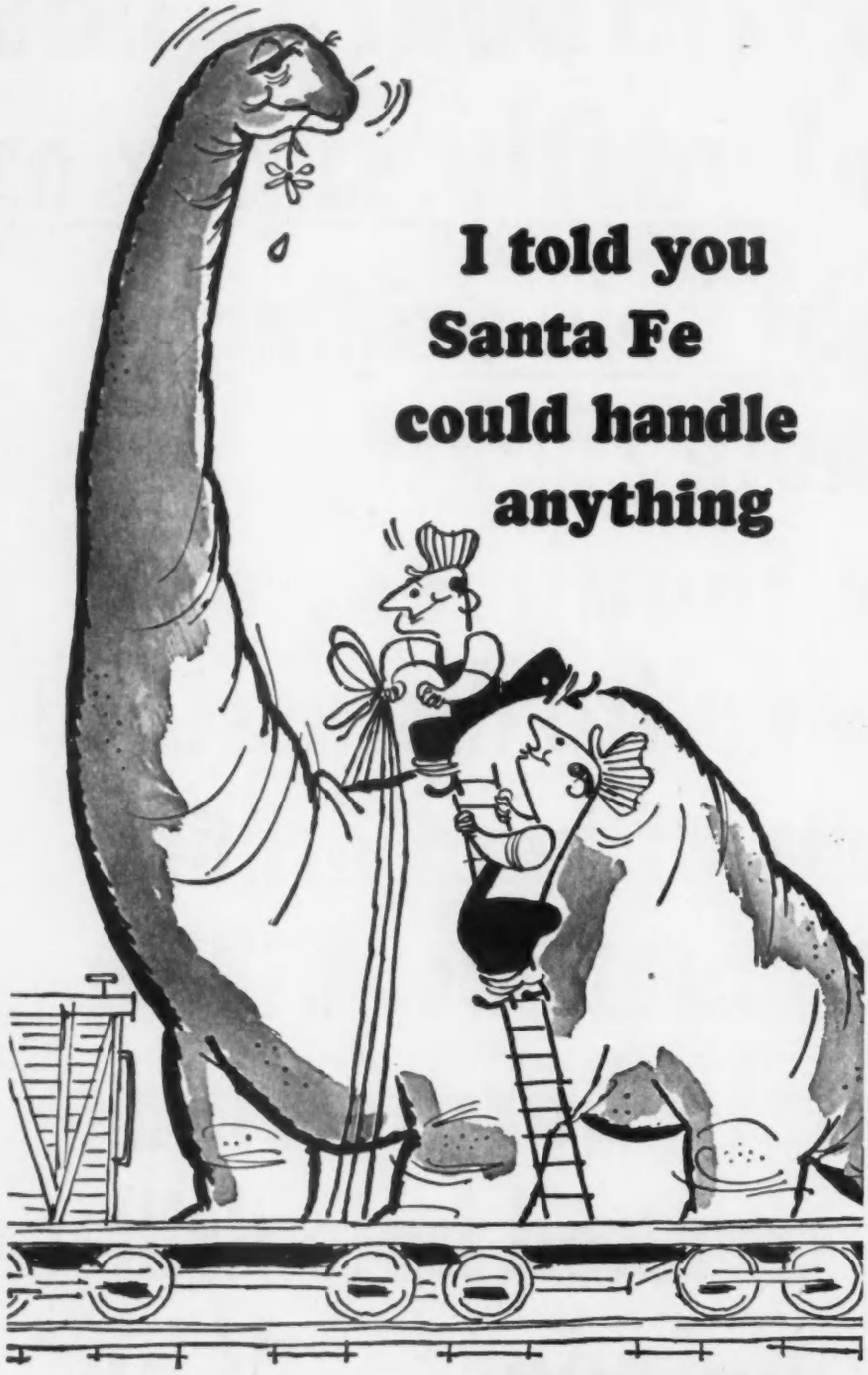

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istering work of the Geological department throughout the Southwest division, which stretches from Florida to Arizona. The position of assistant division chief geologist formerly was held by **Paul W. McFarland,** who was named manager of the Latin American division's Geology and Geophysics department when Sun announced formation of a Foreign Operations department last November.

•

J. Langford Shaw

Charles A. Shaw

J. Langford Shaw, Oklahoma oil producer from Ada, Okla., has announced the opening of offices in the Mercantile Securities Building in Dallas. Shaw has been active in land-leasing and drilling in Oklahoma, Texas and the Southeastern states for the past 30 years. Since 1947 he has been primarily engaged in drilling and production in North Texas and Oklahoma, and was the discoverer of the Wetley pool in Seminole and Pontotoc counties, Oklahoma, in 1952. In his new offices Shaw will be associated with **Charles A. Shaw,** who recently resigned as senior geologist in charge of the Mid-Continent, West Texas, Rocky Mountain and Canadian areas for Union Oil and Gas, Houston. Prior to joining Union he worked as an independent operator.

•

Arkansas Fuel Oil Corporation has promoted or transferred six of the Exploration division personnel. **J. William Schmotzer** is promoted to chief geologist from his former position of assistant chief geologist. **Dr. J. K. Rogers,** formerly manager of the Ark-La-Tex division office has been named regional geologist. He will be located in the company's home offices in the Slattery building, Shreveport, La. **A. V. Hargis,** formerly manager of the Lafayette office, has been transferred to Shreveport as manager of the Ark-La-Tex Exploration division. **K. S. Briggs,** division geologist at Lafayette, has been transferred to the Jackson, Miss., office and has been promoted to division exploration manager. **J. C. Bianchi** has been promoted to division manager and will take over the management of the Lafayette Exploration office. He was formerly division geologist at the San Antonio office. **L. B. Smith, Jr.,** formerly manager of the Jackson, Miss., Exploration office, has been transferred to Shreveport and will serve as division geologist in the Ark-La-Tex division Exploration office.

•

Robert W. Ward was elected vice president of the **Shelton-Warren Oil Company.**

•

Garvey Drilling Company announced the promotion of **Arnold G. Radke** to the position of general drilling superintendent

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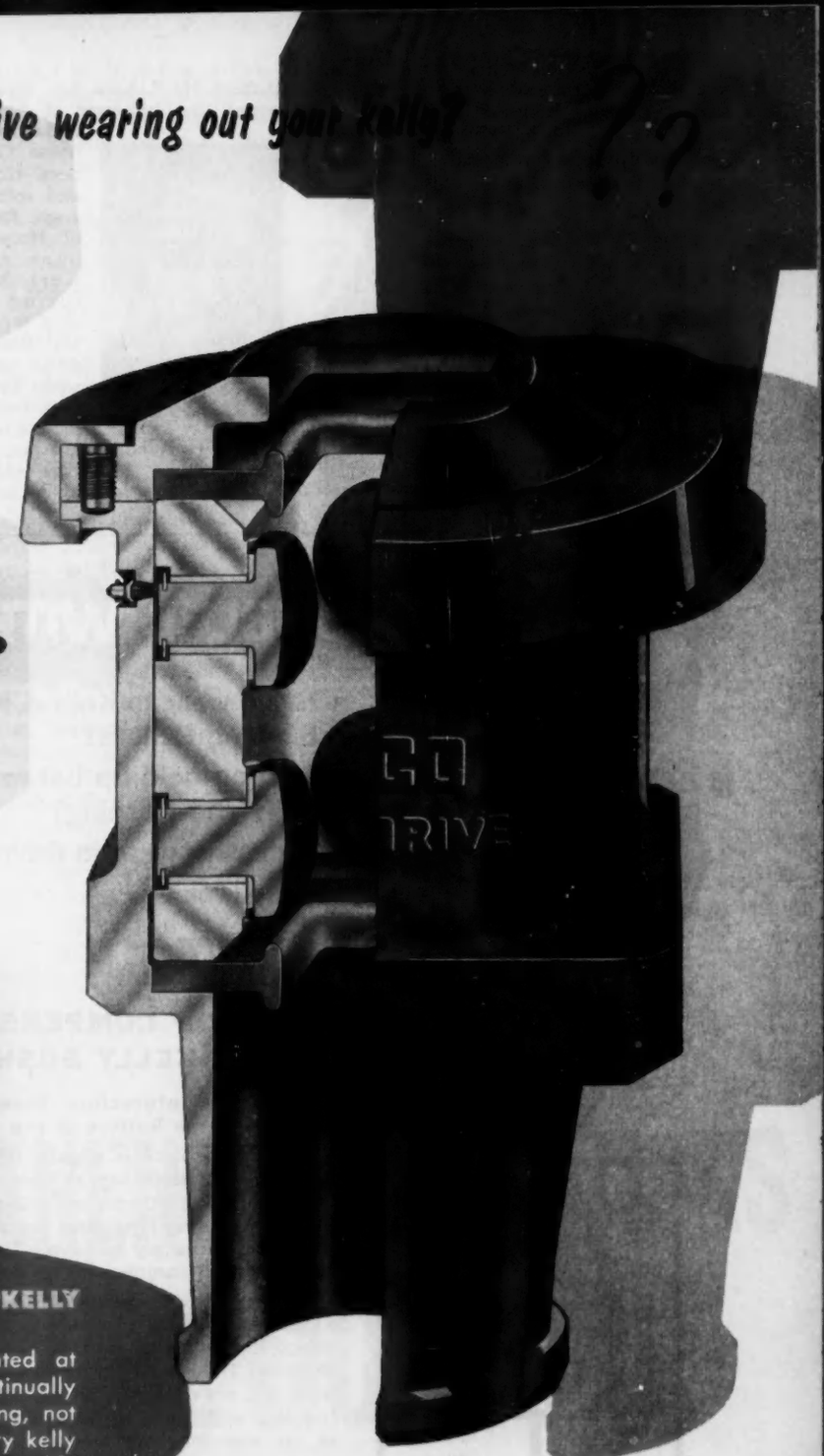

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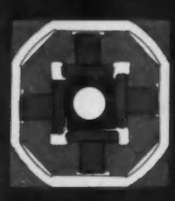

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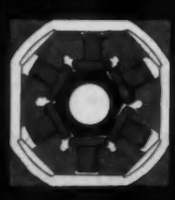

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and the promotion of **Calvin Roberts** to drilling superintendent, Kansas-Oklahoma district. In his new job Radke will oversee the operation of 17 rotary rigs in Kansas, Oklahoma, Colorado and Nebraska.

•

Anthony F. Keating, president of the Keating Drilling Company, will be chairman of the housing bureau for the **1959 International Petroleum Exposition.**

•

Fred B. Asche, Jr., was appointed to the Dallas administrative staff of **Tekoil Corporation.** He was formerly associated with Chubb & Son, marine underwriters of New York and New Jersey and with Great National Life Insurance in Dallas.

Hubert H. Raborn has been elected secretary and treasurer of **Kerr-McGee Oil Industries, Inc.,** Oklahoma City. He has been vice president and secretary of Triangle Refineries, Inc., of Houston, a company acquired by Kerr-McGee this spring and operated as a separate subsidiary. Raborn will continue in his position with Triangle. Three men will serve as assistant secretaries and assistant treasurers of Kerr-McGee: **S. B. Robinson,** who has served as assistant secretary and assistant treasurer of the company since 1951; **W. O. Holdren,** formerly assistant secretary and assistant treasurer of the Deep Rock Oil Company, a subsidiary absorbed by Kerr-McGee in May, 1956, and **J. H. Lollar, Jr.,** formerly secretary and treasurer of Kerr-McGee, since July 1 treasurer of Triangle Refineries, Inc.

Hubert H. Raborn

•

Tidewater Oil Company's Central division Production department has announced several appointments. **Raymond H. Coe,** divisional petroleum engineer, has been advanced to assist manager of production with headquarters at Tulsa. **Wendell J. Haugh,** assistant divisional engineer, will replace Coe as divisional petroleum engineer. **William E. Perkes,** production manager of the four-company oil exploration and production group at Regina, Saskatchewan, Canada, which Tidewater serves as operator, moves to Tulsa as assistant divisional petroleum engineer, replacing Haugh.

•

Rex Shaver has been appointed assistant to the president of **Rimrock Tidelands, Inc.** Shaver will co-ordinate the Company's contract drilling activities and serve as the president's representative in the Gulf Coast area. He will headquarter in the Gulf Coast division office of Rimrock Tidelands in New Orleans. Shaver became associated with Big Chief Drilling Company of Mississippi and affiliated companies as a contract representative in 1948. When an affiliated company, Big Chief Western Drilling Company, changed its name in 1951 to H. L. Rowley, Inc., Shaver was elected vice president, directing the company's production and drilling operations. He advanced to executive vice president in 1955 and to president in February, 1956.

Rex Shaver

•

Ernest J. Dickinson has been promoted from assistant foreman to production foreman in **Magnolia Petroleum Company's** Lake Charles Producing district.

•

Loren L. Ware, assistant division manager of the Midland, Texas, division, has been named general superintendent of exploration for **Sinclair Oil & Gas Company** and transferred to company headquarters in Tulsa.

•

D. S. Godshalk has been promoted to assistant manager of **Continental Oil Company's** Geophysical section, with headquarters in Houston. He formerly was superintendent of operations for Conoco's Geophysical section. Godshalk joined Conoco

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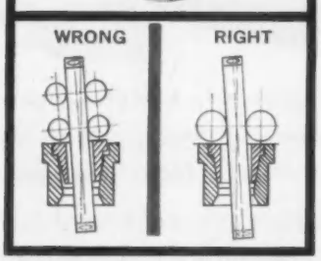

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n 1940 and served on geophysical crews n several states before transferring to Ponca City, Okla., in 1949. He has been uperintendent of operations for the company's Geophysical section since 1953.

•

E. Clyde Seymour has been named senior vice president of **Magnolia Petroleum Company.** His career with Magnolia began in 1912 when he was employed by Magnolia as a messenger boy at its general offices in Corsicana, Texas. He is the only active member of the organization who saw service with the company headquarters before they were moved to Dallas in 1914. He advanced through the Producing Accounting department to his appointment as assistant comptroller in 1941. In 1942, he was made comptroller, and in 1945, was elected to the board of directors and to the position of treasurer. His appointment as vice president followed the next year.

E. Clyde Seymour

•

Joseph W. Lea was promoted to regional geologist o. Sun Oil Company's Southwest Production division. Lea, a senior geologist in the division headquarters at Dallas for the past two years, now will supervise geological work in the four eastern districts, which are headquartered at Tyler, Texas; Shreveport, La.; Jackson, Miss.; and Tallahassee, Fla.

Dr Edward W. Hard, regional geologist for this Eastern region since 1949, now will direct the Western region, which includes districts headquartered at Roswell, New Mexico; and Midland, Abilene and Amarillo, Texas. This region formerly was supervised by **Wallace Ralston,** who recently was named assistant division chief geologist-operational.

•

J. L. Sleeper, Jr., has been appointed staff geologist of **The Texas Company's** Producing department—Domestic with headquarters in New York. Sleeper has been assistant division geologist, West Texas division, at Fort Worth, Texas, since September, 1956. He joined Texaco in 1941 as a Scout in Midland, Texas.

•

E. W. Dissler was appointed resident manager of **Canada-Cities Service Petroleum Corporation** with headquarters in Calgary. Dissler returns to Calgary after nearly three years spent in Bartlesville, Okla., as assistant chief geologist of Cities Service Oil Co. From 1950 to 1954 he was associated with Canada-Cities Service Petroleum Corp. in Calgary as division manager.

Breene M. Kerr

J. B. Saunders

Kerr-McGee Oil Industries, Inc., has elected two new directors. They are **J. B. Saunders** and **Breene M. Kerr.** The action brings to 14 the total number of directors. Saunders is president of Triangle Refineries, Inc., of Houston, a company acquired this spring by Kerr-McGee. He began his career in the oil industry as a shipping clerk for Imperial Refineries, and resigned as general sales manager of that company to organize Triangle in 1937. Kerr joined the company's Exploration department in 1953. Transferred to the Marketing division in 1956, he is now system evaluation engineer.

•

J. E. Finley has been promoted to the newly created position of assistant regional manager of exploration for **Continental Oil Company's** Southwestern region, with headquarters in Fort Worth. He formerly was assistant to the manager of Conoco's

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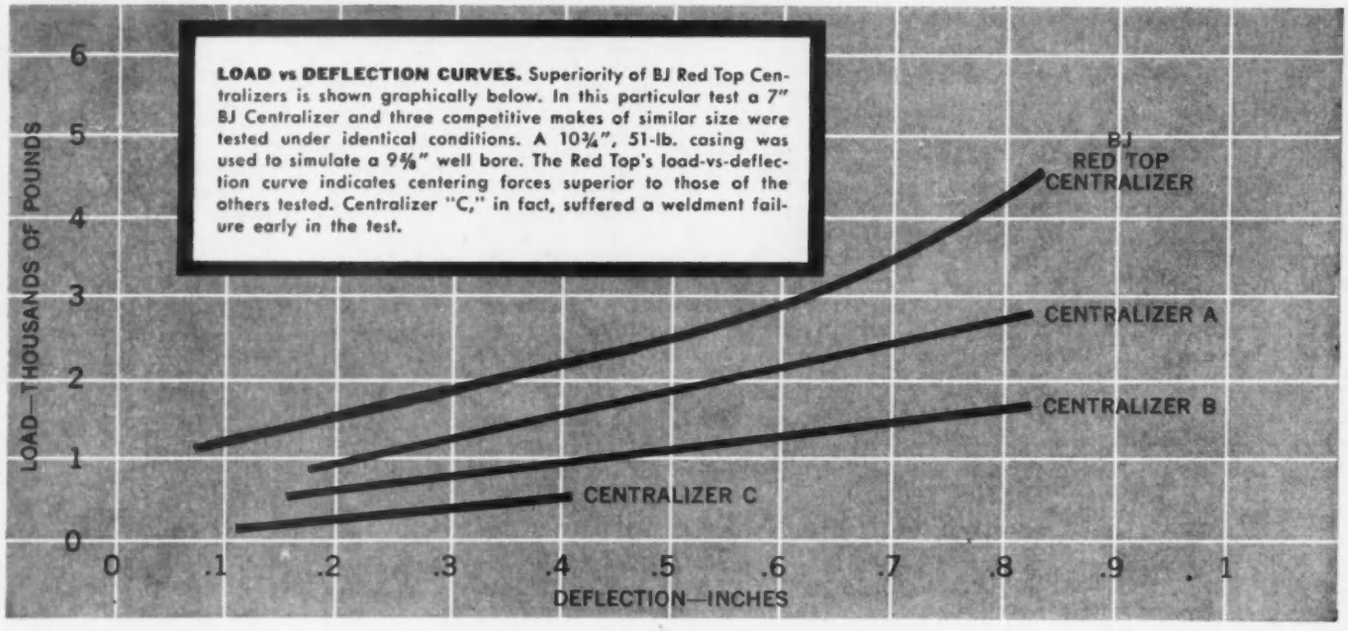
BJ Centralizers


LOAD vs DEFLECTION CURVES. Superiority of BJ Red Top Centralizers is shown graphically below. In this particular test a 7" BJ Centralizer and three competitive makes of similar size were tested under identical conditions. A 10¾", 51-lb. casing was used to simulate a 9⅝" well bore. The Red Top's load-vs-deflection curve indicates centering forces superior to those of the others tested. Centralizer "C," in fact, suffered a weldment failure early in the test.
LOAD—THOUSANDS OF POUNDS
0
1
2
3
4
5
6
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1
DEFLECTION—INCHES
BJ RED TOP CENTRALIZER
CENTRALIZER A
CENTRALIZER B
CENTRALIZER C

Test results confirmed by an independent testing laboratory

Now for the first time there is tangible evidence of centralizer performance. A series of rigorous tests have been made upon stock samples of representative makes of casing centralizers used in the oil fields throughout the world. These centralizers were put through stresses that simulated the most grueling down-hole conditions. And in every case, BJ Red Top Centralizers outperformed all the competitive models tested.

These outstanding findings were far from accidental. With typical thoroughness, the Byron Jackson Division of Borg-Warner Corporation had subjected the BJ Red Top Centralizers to a battery of tests that were even more stringent than the subsequent independent project. The centralizers underwent several years of exhaustive study, design, tests, redesign, and more tests before they were offered to the petroleum industry.

Meticulous single-spring tests were made by BJ technicians to develop the best individual spring characteristics as well as the optimum resiliency of the assembled units. These tests were possible only because of BJ's exclusive *weldless, rivetless design,* which permits use of a higher quality alloy spring steel.

Only BJ Centralizers have the combination of features that guarantee you an efficient, trouble-free cementing program and maximum protection for your down-hole dollar. Get full particulars from your BJ field man or write Byron Jackson Tools, Inc.

best by test!

These points put BJ Centralizers on top in rugged competition

No load on casing! Springs fulcrum on cage. Casing always rotates freely.

Pre-stressed springs give higher initial load—assure maximum centering force with minimum set.

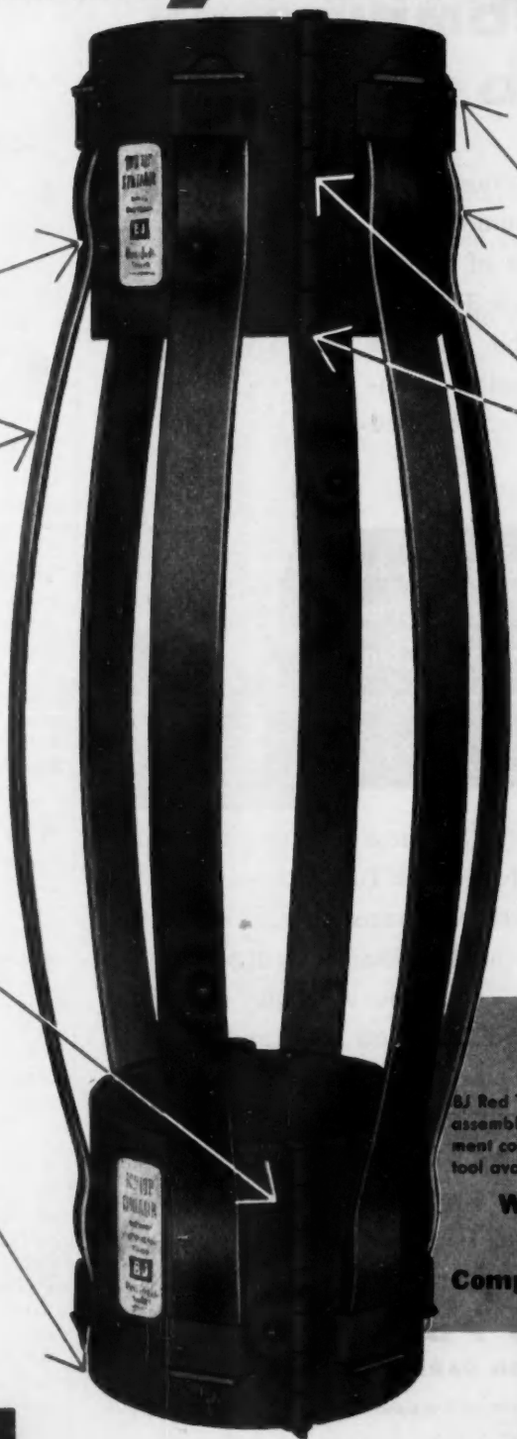
Rivetless, weldless construction makes possible the use of highest quality alloy spring steel...

Slim design allows easy insertion into the hole.

Hinged design offers quick, simple clamp-on.

End cages can't hit well bore, regardless of side load.

Choice of 1¼", 1½", 1¾" or 2" (color-coded) cambers.



Cambers dimensioned before pre-stressing and assembly. You always get the required assembled o.d.

Positive double retaining feature locks pin with dimple in middle and bend at end.

End of spring is curved so spring-holder can never hit wall.

Self-aligning, weld-on type stop collar furnished for use when centralizer is not located on casing collar.

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BJ Red Top Centralizers can be shipped disassembled, offering big savings on shipment costs—particularly for export. Assembly tool available.

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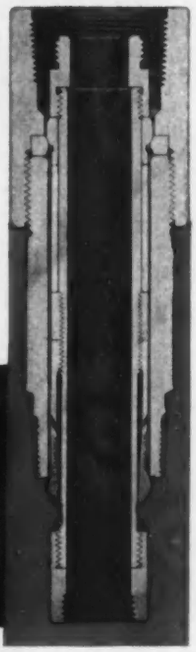
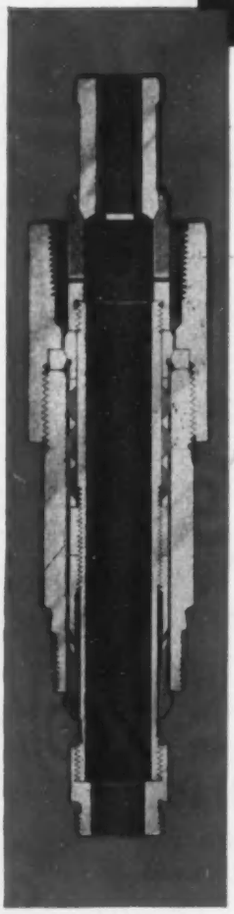
PUMP HOLD DOWN

The Pacific Permanent Completion Hold-Down is designed with maximum opening through the shoe to permit use of Permanent Completion Tools through it. The sealing arrangement has replaceable Stainless Steel Sealing Ring with a reversible Stainless Steel Sealing Ring Seat and can be used on any type A.P.I. rod pump.



Undersize rings can also be furnished to allow pumps to be run through a Permanent Completion "S" Nipple and seated in the pump shoe.



If at any time the Stainless Sealing Ring Seat, which is part of the Tubing Assembly, should become damaged or leak, an effective seal can be obtained without pulling tubing. The Rod Assembly is engineered and designed so that by replacing the Spacer Ring on the Hold-Down Lock Body with three Ring Type Seating Cups, the seal is transferred to the Seat Support Nipple with the Sealing Ring and Sealing Ring Seat serving as a No-Go ring and supporting the load.

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headquarters geophysical section at Houston. Finley joined Conoco in 1948 and served on geophysical crews in several states and as a supervisor at Oklahoma City before becoming division geophysicist at Roswell, N. M., in 1952. He transferred to Midland, Texas, in 1954 as division geophysicist and was promoted to division manager of exploration at that location the following year.

•

Joseph Walla, Jr., has joined **Northern Natural Gas Producing Company** as district geologist at Calgary, Alberta, Canada. The producing company is a subsidiary of Northern Natural Gas Company. Walla has approximately 14 years experience in the petroleum industry. Prior to joining Northern Natural Gas Producing he was associated with Creole Petroleum Corporation for approximately ten years in Venezuela, S. A.

Joseph Walla, Jr.

•

The Bell Oil and Gas Company, Tulsa independent producer, refiner, and marketer, announced the addition to its staff of **Dr. August Goldstein, Jr.**, as chief geologist. Dr. Goldstein's joining the Bell group presages an accelerated exploration program for the company. Prior to his joining Bell, Dr. Goldstein was associated with Pan American Petroleum Company.

•

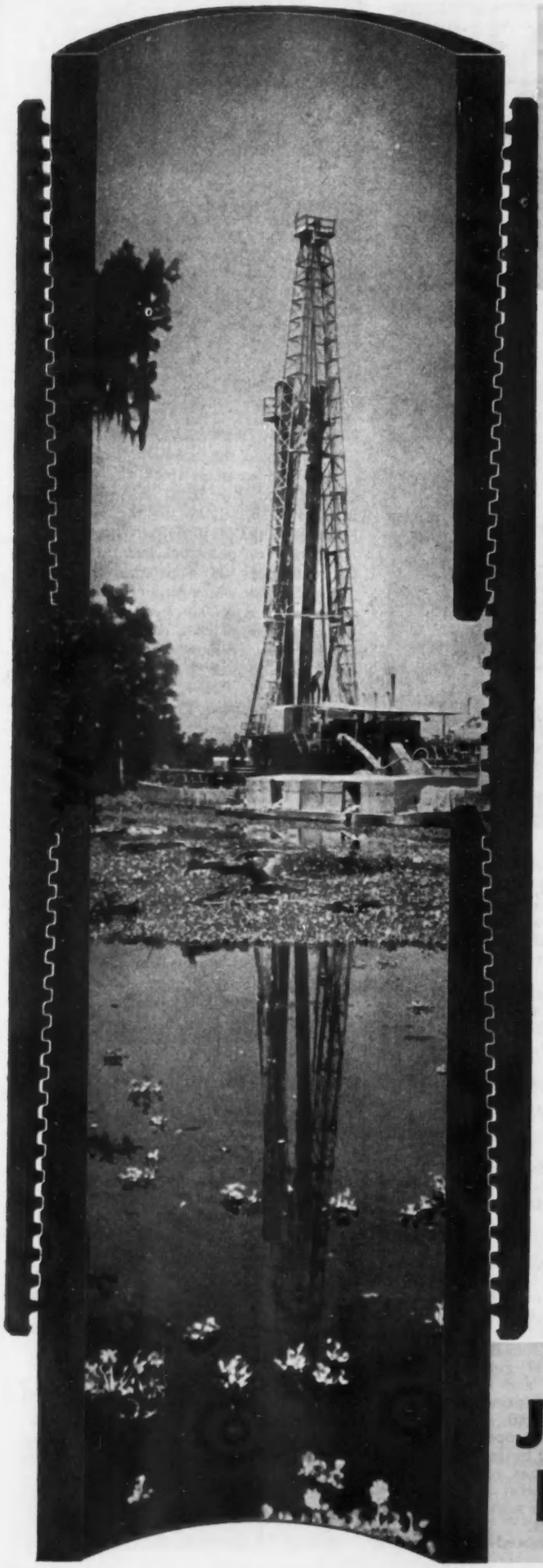
W. R. Lund has been named production manager of **Shell Oil Company's** New Orleans Exploration and Production area. He succeeds **J. W. Pittman**, who is on an extended leave of absence as a result of a serious automobile accident. Lund, who has a record of more than 24 years of service with Shell, has spent the majority of that time in various engineering assignments. Prior to his new assignment, he was area production manager in Calgary, Canada.

•

Keith L. Diehl has been elected vice president of **Drilling and Exploration Company of Delaware, Inc.**, with headquarters in Dallas. Diehl was formerly manager of drilling and production for **Edwin W. Pauley**, with offices in San Antonio, Texas.

•

Arthur E. Dietert was appointed Cities Service representative on the CATC Management Committee, with headquarters in Houston. The CATC group (Continental, Atlantic, Tidewater and Cities Service) is engaged in oil and gas exploration and development in the off-shore areas of Louisiana and Texas. Dietert joined Cities Service as a scout in 1929. Since 1930 he has held various positions in the Geological division of the Company, becoming southwestern division geologist with headquarters in Fort Worth, in 1951.



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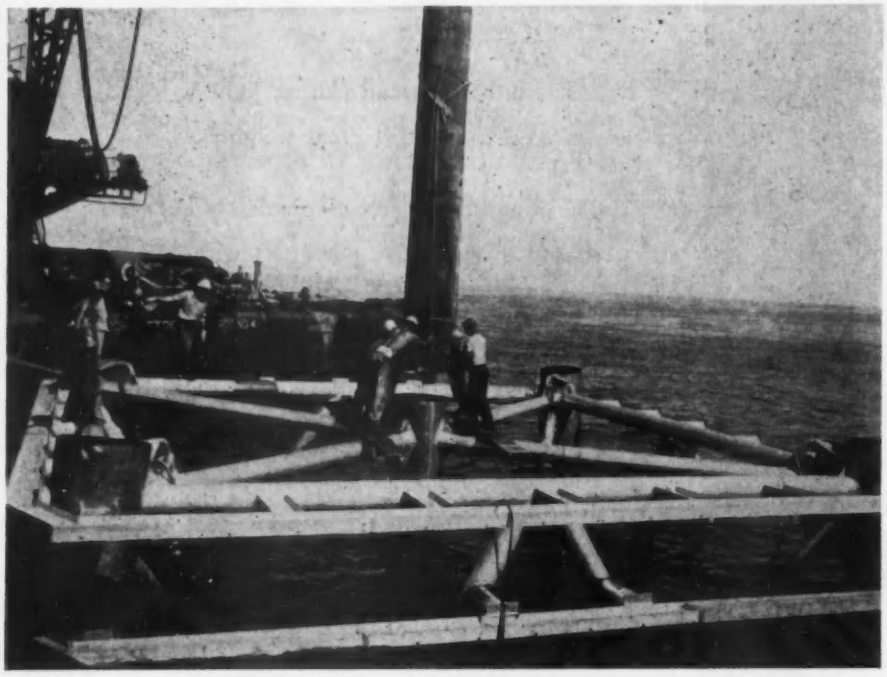


First Aluminum Offshore Platform Erected in Venezuela

The world's first aluminum offshore oil well drilling platform has been erected in Lake Maracaibo, Venezuela. This prefabricated platform, and three others now being installed, are termed the largest all-welded aluminum structures ever built. The initial structure rises 111 feet from the bottom of this oil-rich Venezuelan lake, while the others range up to 121 feet in height. They reach about nine feet above water level. The initial installation was made for the Superior Oil Company of Venezuela. The second is scheduled for a combine consisting of Venezuelan Sun Oil Company (operator), Pan-Venezuela Oil Company, Venezuelan Atlantic Refining Company and Seaboard Oil Company. The other two are scheduled for the following combine: Signal Exploration Company (operator), Hancock Venezuela Oil Company, Pure Oil Company of Venezuela, Inc., and Sohio Venezuela Company.

TEKOIL CORPORATION has agreed to purchase 55 producing oil wells and 16 gas wells along with 34,212 net acres of non-producing leases and royalties in Oklahoma, Alabama, Arkansas, Colorado, Florida, Mississippi, Montana, North Dakota and Texas. Included in the agreement are all the oil properties of Texolina Oil Company and personal properties of its president, **Kenneth Ellison.** For Tekoil, the acquisition will mean an immediate addition of 216 net barrels daily of oil production and 1013 mcf of daily natural gas production. An estimated one million barrels of oil and more than 7,000,000 mcf of gas will be added to Tekoil's reserves.

•

SHELL OIL COMPANY has made the Interstate Petroleum Communications, Inc., a wholly-owned subsidiary and changed the name to **SHELL COMMUNICATIONS, INC.** The company was organized in 1928 to provide radio communications service for the Shell companies in the U. S. **E. J. Strawn,** vice president, and **R. L. Ransome,** chief engineer and operations manager, are in charge of the company's activities from their offices in Houston.

•

WESTATES PETROLEUM COMPANY has been purchased by American and Canadian oil and financial interests, **H. W. Thompson,** newly elected president of the company, announced. Westates, which through its operating subsidiaries produces crude oil and natural gasoline in California, New Mexico and Wyoming, has also acquired by acquisition of Hamilton Dome Oil Company, Ltd., the interest in the Hamilton Dome properties in Wyoming, formerly owned by Indian Oil Company. Westates also has entered into an agreement with General American Oil Company of Dallas to acquire its interest in the same properties.

Directors also approved a program to simplify the company's various operating subsidiaries by merging Westates Petroleum of Nevada and Westates Petroleum Corporation of Texas into the newly acquired Hamilton Dome Oil Company, Ltd. Drilling activities in East and West Texas, Oklahoma and Western Canada will be carried on by Westates Petroleum as a result of its recent acquisition of the operating assets of Canadian British Empire Oil Co., Ltd., and its subsidiaries. The producing and non-producing properties just acquired from Canadian British Empire Oil Co. Ltd. will be transferred to the newly merged operating subsidiary, Hamilton Dome Oil Company, Ltd. The new management states that its newly acquired subsidiary, Arrow Drilling Company of Tulsa, is moving equipment immediately into the Hamilton Dome field to commence the development program.

•

DOUGLAS OIL CO. OF CALIFORNIA has completed the acquisition of 98.8 percent of the common stock of **Apex Petroleum Corp., Ltd.,** and will operate the firm as a subsidiary for the time being. Following the initial purchase of two-thirds of the Apex stock last July, Douglas Oil embarked on a program to acquire the additional outstanding stock. Acquisition of the Apex stock was accomplished through issuance of a combination of 5½ percent-12-year convertible debentures and cash. New officers of Apex Petroleum have been elected. They include **George T. Goggin,** president; **T. A. Atkinson,** executive vice president; **J. M. Jackson,** vice president; **R. L. Tollefsen,** secretary; **D. L. Commons,** treasurer and assistant secretary; and **W. B. Seaton,** assistant treasurer.

•

THE TEXAS COMPANY announced that it proposes to contract for the building of six additional 46,000 deadweight-ton tankers for use in foreign service. Specifications call for a designed service speed of 16½ knots, and the "newbuildings" will supplement the company's present and contracted for fleet of crude oil carriers.

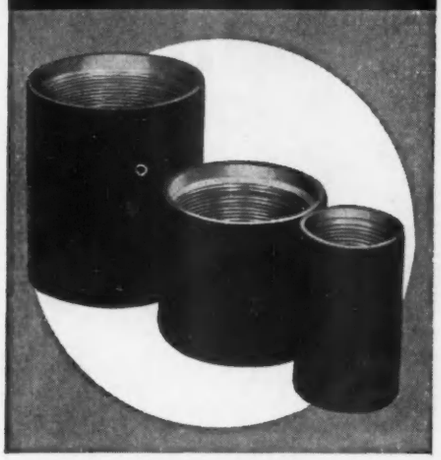
•

HOLIDAY OIL AND GAS CORPORATION of Oklahoma City has changed its name to **WHITE STAR OIL COMPANY.** White Star has recently acquired majority interest in Utah Consolidated Oil Company which holds substantial interests in 10,500 acres of mineral interests near Ocean City, Wash. Utah Consolidated also wholly owns the North Coast Drilling Company. **Harold Kincaid,** former inspector of oil and gas for the State of Washington, will be field supervisor of operations at Ocean City.

•

TEXAM OIL CORPORATION, has sold its 50 percent interest in **ADKINS DRILLING COMPANY** for $40,000 cash to **John J. Adkins,** founder and managing partner of the drilling company. In addition, Texam has agreed to assign to Adkins an undivided one-half interest in Gonzales County, Texas, leaseholds which are among the assets of Adkins Drilling.

ALL COUPLINGS
for the oil industry



A.P.I. LINE COUPLINGS

Sizes ⅛" through 12", 14" and 16" O.D. Black and Galvanized. Recessed, Taper Tapped ¾" per foot.

A.P.I. CASING COUPLINGS

Short and Long, sizes 4½" through 13⅜". All threads 8 round, ¾" taper per foot. Combination casing couplings also available.

A.P.I. TUBING COUPLINGS

Non-Upset sizes 1.900" through 4½". Upset sizes 1.660" through 4".

OTHER OIL INDUSTRY ITEMS

Couplings-Standard Merchant, 3000 and 6000 lb. Hydraulic and all other types of special couplings.
Hex Bushings, Square Head and Hex Head Solid Plugs, Nipples, Unions, Steel Socket Weld Couplings and Caps.

CAP CAPITOL
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COLUMBUS, OHIO

COUPLINGS — NIPPLES — UNIONS — RADIANT HEAT FITTINGS — FURNACE COILS — WELL SUPPLIES — STEEL PIPE FITTINGS

DEATHS

R. C. Baker, founder and chairman of the board of Baker Oil Tools, Inc., died September 29 at a Whittier, Calif., hospital. A pioneer in California oil activities, Baker was a drilling contractor and oil operator. Shortly after the turn of the century he began to manufacture and market oil tools of his inventions. The Baker Casing Shoe Company was founded in 1912 and subsequently became Baker Oil Tools, Inc.

R. C. Baker

Erle Palmer Halliburton, 65, founder of the large oil well servicing company, died in a Los Angeles hospital October 13. Halliburton incorporated his company in 1924 after several years of operating on his own "shoestring" finances. His company practiced improvements on the then present cementing ideas. Since then Halliburton Oil Well Cementing Company in Duncan, Okla., has grown, and Halliburton has operated a Honduran gold mine, the Halliburton Portland Cement Company, a southwestern airline that has since merged with American Airlines, has been granted more than 50 patents and founded a Los Angeles travel case plant. He was also active in philantropic work.

Erle P. Halliburton

Gaither L. Jones, 72, independent oil operator, died September 22 in a Houston hospital. He formerly was head of Gulf Oil Corporation's Treasury department, with Humble Oil & Refining Company and later an independent in Louisiana. Jones sold the prolific LaFitte field south of New Orleans to The Texaco Company in the 1930's.

Herbert A. Yocom, consulting editor of Petroleum Week magazine, died August 23 at his home in Stanford, Conn.

Henry B. Suhr, 55, Pennsylvania independent oil operator, died August 27 in Pittsburgh, Penn. A director of South Penn Oil Co., he served in World War II as a major with the Army-Navy Petroleum Board in Washington, D. C.

Charles T. Williams, 71, oil production expert and geologist, died in Cleveland, Ohio, August 25. He is credited with bringing in the first well in Pennsylvania's Tioga oil field.

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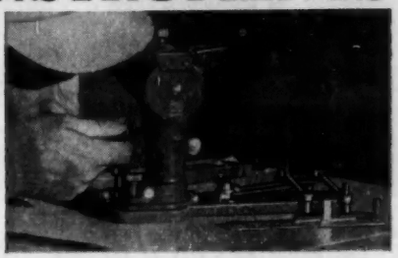

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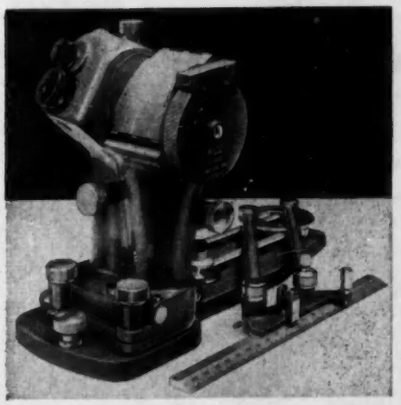

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New York Golf Party

The Fall Golf Party of the New York Chapter of Nomads was held recently at the Westchester Country Club. Shown left to right are J. Moore, Chain Belt Co., low gross guest; J. Chanda, A. O. Smith Corp., low gross runner-up Nomad; J. Wilson, The Lummus Co., low net runner-up Nomad; and E. Gahan, E. F. Gahan, Inc., low gross Nomad.

what's Happening

among INDUSTRY ASSOCIATIONS

Dallas-Fort Worth Nomads

Fred Carlson, director of business research, Dresser Industries, addresses the September meeting of the Dallas-Fort Worth Nomads chapter.

Foreign Guests in Houston

Present at the August meeting of the Houston chapter of Nomads were the following foreign guests: (Left to right, front row) E. S. Hulsman, Shell Oil Co., Bogota, Colombia; J. T. Johnson, Creole Petroleum Corp., Maracaibo, Venezuela; and Chester H. Lauck, (Lum of "Lum and Abner"), Continental Oil Co., Houston. (Left to right, back row) R. R. Davila, consul general of Venezuela, Houston; R. Ach, S. N. Marep, Paris, France; R. H. Johnson, Standard Vacuum, Polembang, Sumatra, Indonesia; and Oscar Schubert, Cal Tex, Sumatra, Indonesia.

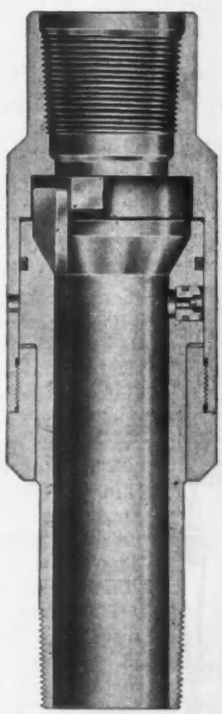
Smith Addresses Los Angeles

Guest speaker and foreign guests at the September meeting of the Los Angeles chapter of Nomads. Left to right (standing) are Ralph C. Charlesworth of Oil Well Engineering Co. from England; B. L. Coker of Mosul Petroleum Co. from Iraq; H. V. Hale of Gulf Oil Co. from Mozambique; Simon Stein of Petrobras from Brazil; Francisco de C. Nogueira of Petrobras of Brazil; Nick Rizzo of S. H. P. from Italy; (seated) Jerome H. Riewer of Baker Oil Tools from Venezuela; Elmer E. Jones of Shell Oil Co. from Venezuela; Clipper Smith, guest speaker; Frank R. Wilmer of Shell Oil Company from Venezuela; J. B. Aquino of Formac from Brazil.

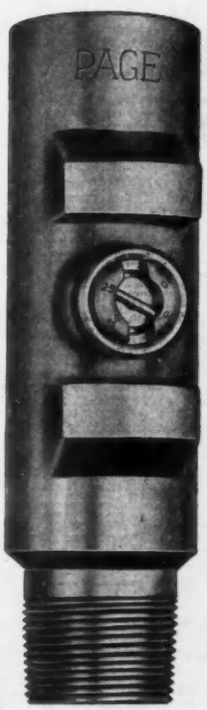
Oil INDUSTRY

TENSION* TOOLS

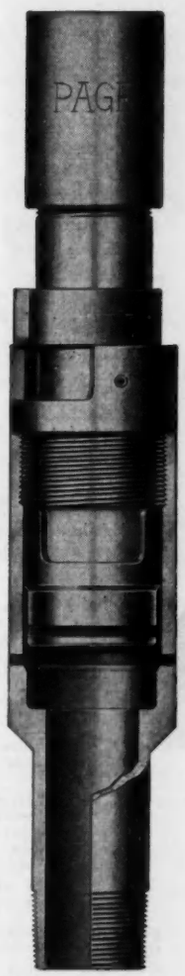
PAGE Sucker Rod "On and Off" Attachment



PAGE Type "R" Tubing Drain

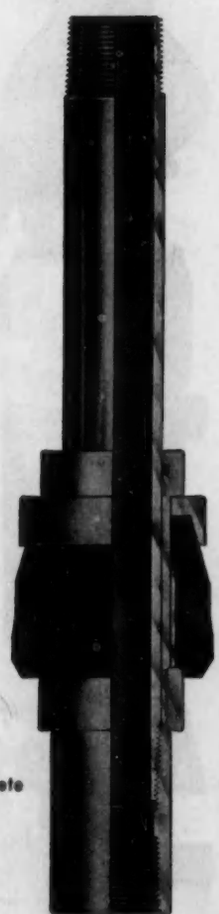


PAGE Type "B" Hydraulic Tubing Drain



PAGE Type "A" Mechanical Tubing Drain

PAGE Bottom Hole Oil and Gas Separator



PAGE Rotating Bottom Hole Packer

PAGE TENSION TOOLS

PAGE

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R. F. Windfohr

J. C. Donnell

Windfohr and Donnell Receive Service Award

Robert F. Windfohr, independent oil producer, and James C. Donnell II, president, The Ohio Oil Co., were selected for the Texas Mid-Continent Oil & Gas Association Distinguished Service Award.

The award goes to an independent producer and a major company executive in recognition of outstanding contributions to development of the oil and gas industry.

API 37th Annual Meeting To Convene November 11

The thirty-seventh annual meeting of the American Petroleum Institute in Chicago will open November 11 and wind up November 13.

U. S. Senators Robert S. Kerr, of Oklahoma, and Everett M. Dirksen, of Illinois, have been added to the program. This was announced by API President Frank M. Porter, who said the two senators will address general session audiences in place of Secretary of the Interior Fred A. Seaton, and Senate Majority Leader Lyndon M. Johnson, of Texas.

Porter explained that both Secretary Seaton and Senator Johnson were forced to change their plans to address the oil men in Chicago because of other commitments, and the press of business affairs.

Senator Kerr will be the third speaker at the first general session on Monday afternoon, November 11, and Senator Dirksen will be the third speaker at the second general session on Wedensday morning, November 13.

Other speakers for the two general sessions include API President Porter; Charlton H. Lyons, president of Mid-Continent Oil & Gas Association, Shreveport, La., and Philip D. Reed, chairman of the board, General Electric Company, New York.

The Conrad Hilton, Palmer House and Congress Hotels will serve as headquarters during the course of the meeting. The Hilton will be principal headquarters. The Palmer House, as it has in the past, will cater to the Transportation division. The Congress, added this year for the first time, will serve as headquarters for marketers.

From 6500 to 7000 oil men and their guests are expected to register for this year's meeting, traditionally the largest single meeting of oil men throughout the country.

NOW! KING 30, 40 and 50 KG SWIVELS
With all the superior features of the King XV Series Swivels, the KG now provides
PACKING-BOX CHANGE
WITHOUT "BREAKING OUT."
New packing box arrangement eliminates necessity of removing gooseneck and bearing housing to change packing, thus eliminating thread-galling.
NEW!
• Washpipe-packing box arrangement permits higher-speed rotation.
• Oversize watercourse makes these swivels ideal for both conventional and reverse circulation methods.
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For drilling relatively shallow oil wells, the deepest of water wells, workover rigs, slim hole drilling and "drilling in" and coring oil wells. Superior performance at 100 rpm to 7,500 feet with 2⅞", 3,800 feet with 4½" drill pipe.
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AIME Names Recipients Of Two Major Awards

The American Institute of Mining, Metallurgical and Petroleum Engineers has announced that the recipients of two of its major awards for 1958 have been selected.

The Robert H. Richards Award will go to Fred D. De Vaney, chief metallurgist, Picklands Mather & Co., Duluth, Minn. The Benjamin, F. Fairless Award will go to Hjalmar W. Johnson, vice president, steel manufacturing, Inland Steel Co., Chicago. Presentations will be at the annual banquet of AIME in New York Feb. 20, 1958.

The Robert H. Richards Award in Minerals Benefication is in memory of Dr. Robert H. Richards, who had been a president and honorary member of AIME. The award is given for achievement that "furthers the art of minerals beneficiation."

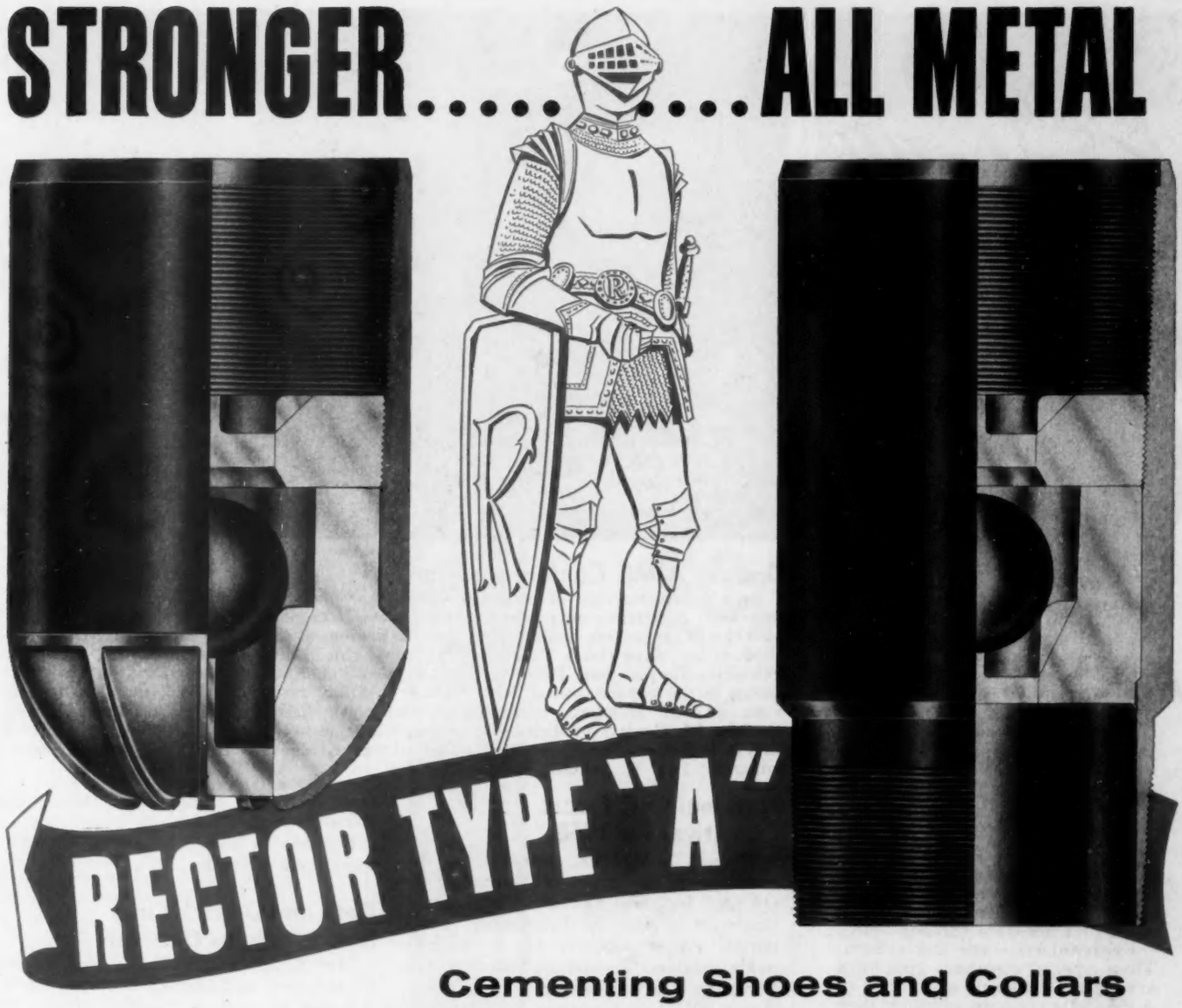
The Benjamin F. Fairless Award, "in recognition of distinguished achievement in iron and steel production and ferrous metallurgy," is designed "to honor Benjamin F. Fairless for his intense interest in the technology and development of the iron and steel industry."

Indiana and Kentucky Geologists Elect Officers

New officers for the year 1957-58 of the Indiana-Kentucky Geological Society are president, John Van Fossen, district geologist, Kewanee Oil Co.; vice president, Avery E. Smith, division geologist, Felmont Oil Corp.; and secretary-treasurer, N. W. (Monty) Montgomery, sales engineer, Schlumberger Well Surveying Corp.

The newly elected executive committee includes Roderick J. Forsyth, past president, consulting geologist, Evansville, Ind.; Jerry Carpenter, geologist, Indiana Geological Survey, Bloomington, Ind.; and Langdon Williams, division exploration geologist, Phillips Petroleum Co., Evansville, Ind.

STRONGER.....ALL METAL



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Precision made for a good cementing job every time!

Rector Type "A" Shoes and Collars are precision machined from high quality seamless steel with internal parts of a special high strength ALUMINUM ALLOY that is readily DRILLABLE. Not only is the ALUMINUM ALLOY far stronger than concrete or bakelite, but is machinable to close tolerances for precision fabrication.

Internal parts are quickly drillable, as there is a minimum of material to be drilled out.

Bullet nose permits the shoe to guide smoothly past ledges and obstructions.

For economical, trouble-free cement jobs, always ask for Rector Type "A" equipment at your favorite SUPPLY STORE.

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Anvil Brand Fittings—A.P.I. couplings for all regular oil field applications, bushings, plugs, and nipples— undergo scientific materials testing and continual gaging during manufacture. They are sold through your nearest supply store, whose engineering service to customers is supported by Anvil Brand Representatives in key locations. Write today for further information.

Home office and main plant: Allison Park, Pa. Anvil Brand Couplings are also manufactured by Anvil Products, Inc., Longview, Texas, and by Canadian Coupling and Fittings, Ltd., Simcoe, Ont., Canada.

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Discuss AIME Conference Plans

At a recent meeting of committee chairmen, plans were developed for a two-day petroleum conference on production and reservoir engineering to be sponsored by the Mid-Continent section, Society of Petroleum Engineers, AIME., to be held March 20-21, 1958, at the Mayo Hotel, Tulsa. Roy H. Smith, chief petroleum engineer, Pan American Petroleum Corporation, Tulsa, (center) is general chairman. Other committee chairmen shown in the picture: seated, left, William E. Stiles, program; seated, right, Robert E. Foss, finance. Standing, left, Don R. Johnson, chairman, Mid-Continent Section; Herbert M. Cooley, publicity. Other committee members not shown in the picture: Ernest L. Petree, arrangements; R. C. Earlougher, registration; H. H. Kaveler, entertainment; Paul R. Schultz, Jr., housing.

National OIC Elects Executives for 1958

Thomas W. Phelps, assistant to the chairman of the board of Socony Mobil Oil Co., Inc., was elected 1958 National Chairman of the Oil Information Committee. Phelps succeeds M. S. Hauser, public relations director of The Ohio Oil Company. He will assume the chairmanship at OIC's next meeting in New York, December 5-6.

Vice chairmen elected were R. H. Collacott, public relations director, The Standard Oil Company (Ohio); Russell D. Karns, assistant to the president, Pan American Petroleum Corporation; G. A. Mabry, manager of advertising and public relations, Humble Oil & Refining Company; and Stewart Schackne, public relations manager, Standard Oil Company (New Jersey).

Donald R. Waugh of the OIC staff, was elected secretary.

Desk and Derrick Picks Mrs. Livada as Director

Mrs. Katherine Livada has been chosen by the Desk and Derrick Clubs of North America to serve as regional director in Region VIII (West Coast). She has also been appointed national chairman of the association's membership committee for the coming year.

Mrs. Livada was vice president of the Los Angeles club in 1952-53 and became president in 1954-55. She has been employed by the Tretolite Company of California for the last 17 years.

Rocky Mountain AIME Committee Men

Host section members of the Program committee for the fourth annual joint meeting of the Rocky Mountain Petroleum sections of AIME are (left to right) Fred Poettmann, Ohio Oil; Henry Mattson, The Texas Co.; Program Chairman R. L. Hoss, Vaughey & Vaughey; A. H. Wieder, Shell; and J. E. Stein, British-American. The meeting will be in Denver, March 3-4, 1958. Casper, Wyo., members of the Program committee are J. E. Lang, Pan-American, and E. L. Spieles, Ohio Oil. Committeemen in Billings, Mont., are F. M. Burback, Mobil Producing and J. A. Pederson, Shell.

New Books, Maps and Movies

CALIFORNIA OIL & GAS FIELD MAP BOOK, Munger Oilogram, 5865 West Blvd., Los Angeles 43, Calif., $20 Postpaid.

Measuring 11 by 17 inches and containing 169 pages of maps of California oil fields, the book has a metal coil type binder so as to lie flat when opened. Covers are of heavy, plastic-coated stock on which is imprinted in two colors, an overall map of California oil fields along with township and range lines.

Fields shown in book are up-dated to within one month of the April 15, 1957, publishing date. The discovery well for each field is indicated on each field map.

•

A SYMPOSIUM ON THE OIL INDUSTRY OF THE PERMIAN BASIN, Texas Petroleum Research Committee, Bulletin No. 58, The University of Texas, Austin, Texas, $1.

The proceedings of the Tenth Oil Recovery Conference, which was held in Midland, Texas, April 18 and 19, in cooperation with the Permian Basin section of the Society of Petroleum Engineering of the AIME is available.

This book is a paper-bound volume, 144 pages containing 15 papers by well-known scientists, petroleum engineers, research workers and oil men. Topics such as interpretation of well logs from carbonate rocks, reservoir performance, the performance and analysis of typical Permian Basin oil fields, interpretation of core analysis in the Permian Basin and various new techniques employed in the completion of wells in the Permian Basin are discussed by the several authors. The volume is replete with illustrations, charts, graphs, tabulations of data and the like.

•

SCHEDULE OF WELLS, Department of Mineral Resources, Record Branch, Regina, Saskatchewan, $5.

This publication includes schedules between Jan. 1, 1955, and Dec. 31, 1956. The 371-page schedule contains:

1. Dates of drilling, casing, drill stem tests, perforations and geological formation boundaries on nonconfidential wells not published in previous schedules.

2. Locations, drilling dates and casing information for wells classified as confidential.

3. Name lists of wells published in three preceding schedules.

•

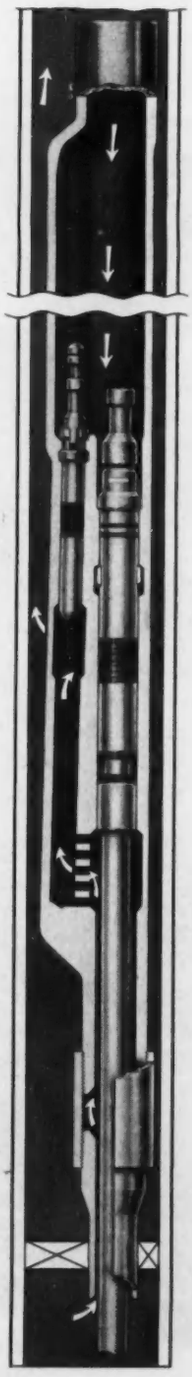
OCCURRENCE OF OIL AND GAS IN WEST TEXAS, Publication 5716, Bureau of Economic Geology, The University of Texas, P. O. Box 8022, Austin 12, Texas, $10.

Dr. John T. Lonsdale, director of the Bureau, said that the publication will be of great value as a reference work on West Texas oil fields and as a source of fundamental facts concerning the occurence of oil and gas generally. The information in the book can be used as the basis for research in exploration.

The book is the result of a cooperative project between the West Texas Geological Society and the Bureau. It is a complete summary of conditions in the oil fields of the area, 112 of which are described. Structure maps, graphic type sections of rocks penetrated, and cross sections are included for most of the fields. Each description also gives the field's location, history, details of oil and gas occurrences in reservoir rocks, stratigraphic and lithologic details of rocks, nature of traps, productive area information on character of oil and gas recovered and production history.

CONSERVATION IN THE PRODUCTION OF PETROLEUM, Yale University Press, New Haven, Conn., by Erich W. Zimmermann, $6.

Here is a study of the program of petroleum conservation, affecting the production of both oil and gas, which has developed in the U. S. from the time of the late 1920's and the early 1930's. Zimmermann examines its history, reviews its legality, exposes its problems and weaknesses and appraises its achievements.



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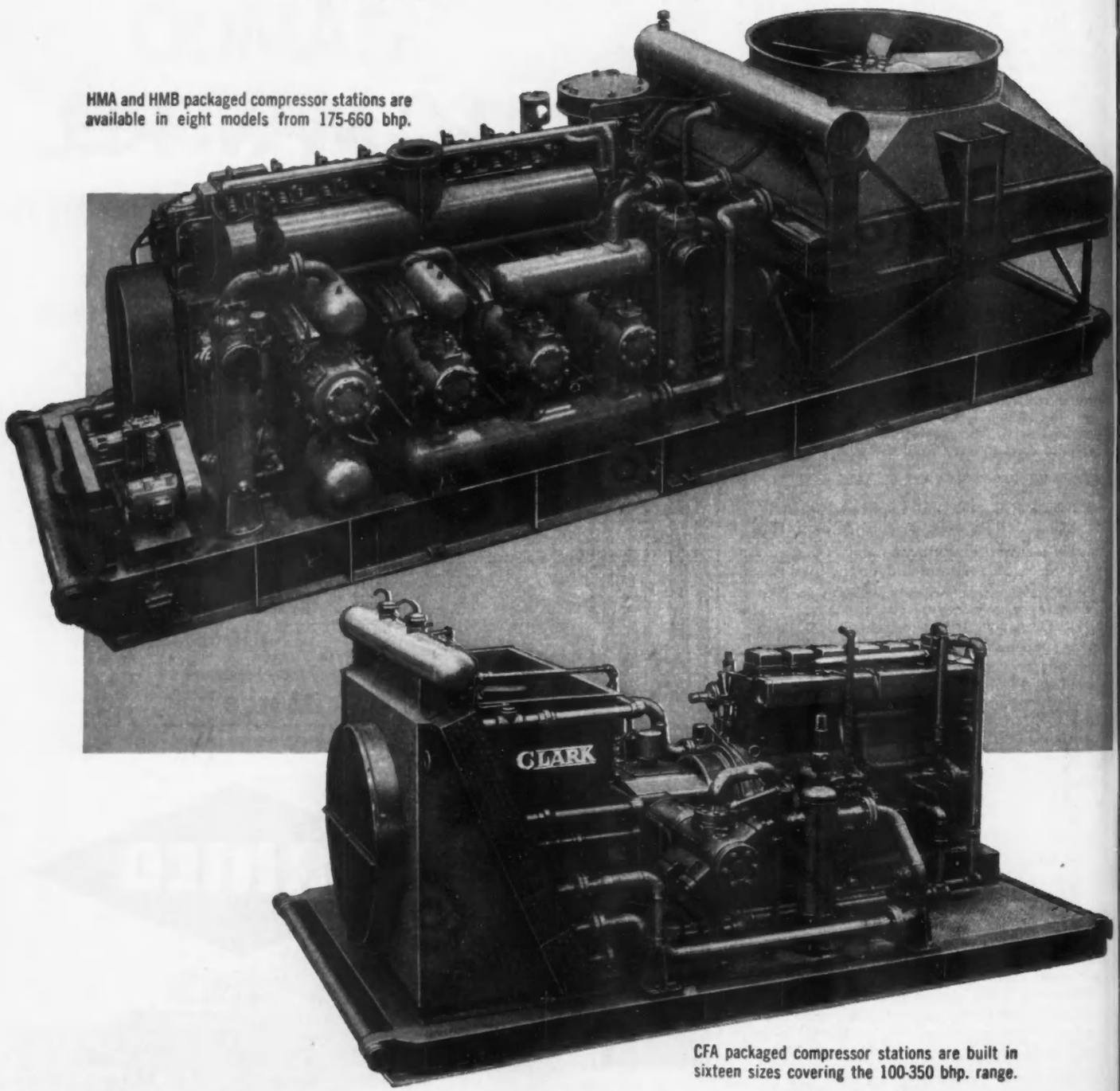

HMA and HMB packaged compressor stations are available in eight models from 175-660 bhp.

CFA packaged compressor stations are built in sixteen sizes covering the 100-350 bhp. range.

CHOOSE FROM!

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Excess horsepower in a field compressor, above and beyond its inherent overload carrying ability, is fine if you have a use for it. But when it is horsepower that can't be made to earn its way, it's money down the hole.

With twenty-four sizes to choose from, Clark can deliver a packaged compressor that's tailored exactly to your horsepower needs in the 100-660 bhp. range. You can realize substantial savings by avoiding the installation of an improperly sized unit just because "it's all that's available".

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Clark CFA, HMA and HMB packaged field compressors are proved machines. They are the only field compressors available that have been specifically designed for the job. Their balanced/opposed design eliminates the need for massive foundations . . . just enough to level them is ample.

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What's Happening

among SERVICE and SUPPLY MEN

Munro Corbin

John T. Farrell

Munro Corbin, controller of **Rockwell Manufacturing Company** since 1951, has been elected vice president and assistant to the president. He is succeeded as controller by **John T. Farrell,** assistant controller since 1953. Corbin's new duties will include coordination of all staff and management committee functions at the company's national headquarters in Pittsburgh, as well as long-range planning and special assignments. He will also be in charge of the company's acquisition program. Corbin joined Rockwell's Accounting department in 1940 and was named assistant controller in 1947. Farrell joined Rockwell's Accounting department in 1946 and became supervisor of headquarters accounting in 1950.

•

Ray E. Leverich, former manager of the Tax division of the Anderson Prichard Oil Corporation of Oklahoma City, has joined the **George E. Failing Company** of Enid, Okla., as director of finance and taxes.

•

The Tretolite Company division of Petrolite Corporation has announced transfer of **Frederick E. C. Jenkins** from the St. Louis office to The Hague. Jenkins has been assistant manager of technical services. In his new position he will be affiliated with the European division of Petrolite Corporation, Petrolite Ltd., and will be located at Hoefbladlaan 134, The Hague, The Netherlands. He will serve as technical engineer, specializing in the applications of Tret-O-Lite demulsifiers and Kontol Corrosion inhibitors throughout Europe and the Middle East. Jenkins has been with the Petrolite organization since 1953.

F. E. C. Jenkins

•

Andrew W. Rose has been elected vice president and assistant to the president of the **Byron Jackson Division** of Borg-Warner Corporation. Rose is also a vice president of Borg-Warner itself. He has been vice president and general manager of the Petro-Mechanics Research division, the Borg-Warner laboratory at North Hollywood, Calif., which is developing the sonic oil well drill. Prior to heading Petro-Mechanics operations he was Pacific Coast representative for Borg-Warner. Rose has been a member of the Supervisory Board of Byron Jackson since the company merged with Borg-Warner in 1955.

•

Murray-Brooks, Incorporated, announced the appointment of **Earl L. Coulter** as Sales manager, Mid-Continent district, with offices in the Mid-Continent building, Tulsa. He has been engaged in the oil field supply business in Tulsa for the past 12 years.

•

Dr. Oscar T. Marzke has been appointed vice president—fundamental research of **United States Steel Corporation.** Dr. Marzke, who is now director of research, U. S. Naval Research Laboratory, was formerly associated with U. S. Steel in the Research department of American Steel & Wire division. His first employment with U. S. Steel was as assistant director of American Steel & Wire's research laboratory in Worcester, Mass., in 1934. He was made associate director of research in 1954 and director of research in 1956.

O. T. Marzke

•

R. J. Graebner was appointed geophysicist for U. S. and Canadian operations of **Geophysical Service Inc.** Graebner's chief duties will be to provide assistance to GSI seismic field parties and data processing centers, in order to increase the technical excellence of these operations. Graebner will also maintain close contact with the research and application sections of GSI's Geophysical Engineering department. In addition, he will work on long-range planning of new techniques and procedures to be used both in the field and in GSI's data processing offices. Graebner joined GSI in 1949 as a computer-trainee. Since that time he has served as a computer and seismologist. He held the position of senior research seismologist prior to being appointed geophysicist for U. S. and Canadian operations.

•

Halliburton Oil Well Cementing Co. has named **Edwin L. Paramore** as a regional vice president. The new southern region vice president is responsible for Halliburton operations in the Shreveport, New Orleans, Houston and Corpus Christi divisions of the company. Paramore joined Halliburton in 1936 as driver of a cementing truck. Following field assignments in New Mexico, Texas, Oklahoma, Kansas, Illinois and Louisiana, he transferred to Halliburton's Duncan, Okla., headquarters in 1956 as southern region manager.

E. L. Paramore

•

Dodge Manufacturing Corporation has announced three new assignments. **Carl K. Shank** is promoted from general superintendent of manufacturing to works manager. **Edwin Rhodes** is appointed purchasing agent, and **Richard Kaiser** is plant engineer, succeeding **Paul Jordan,** who has advanced to the new position of director of engineering. Shank has worked for Dodge since 1935. In his new position he will direct all manufacturing, plant engineering, maintenance and tool design. Rhodes joined the Dodge Engineering department in 1940, transferred to tool design in 1944, and has been special projects engineer since 1946. Kaiser joined the Dodge plant Engineering department in 1955 and has been assistant plant engineer since November, 1956.

•

Edward E. Parker was appointed general manager of **Cameron Iron Works, Ltd.,** Leeds, England. Parker has been in England since 1951 serving first with an affiliated company, British Oil field Equipment Company, and for the last two years as factory manager of Cameron's own plant in England. He started with Cameron in 1941 after working for two years as a roughneck in South Texas oil fields.

E. E. Parker

•

Larkin Packer Company has appointed a product development engineer and added to the Engineering department. **Edward E. (Mike) Temple** is the new product development engineer and **Jack Larkin** has joined the Engineering department. Temple until recently was associated with Drilling and Exploration, Inc., as division

The Most Economical Pumping Unit Ever Built

. . . and the SMOOTHEST OPERATING

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Hydraulic
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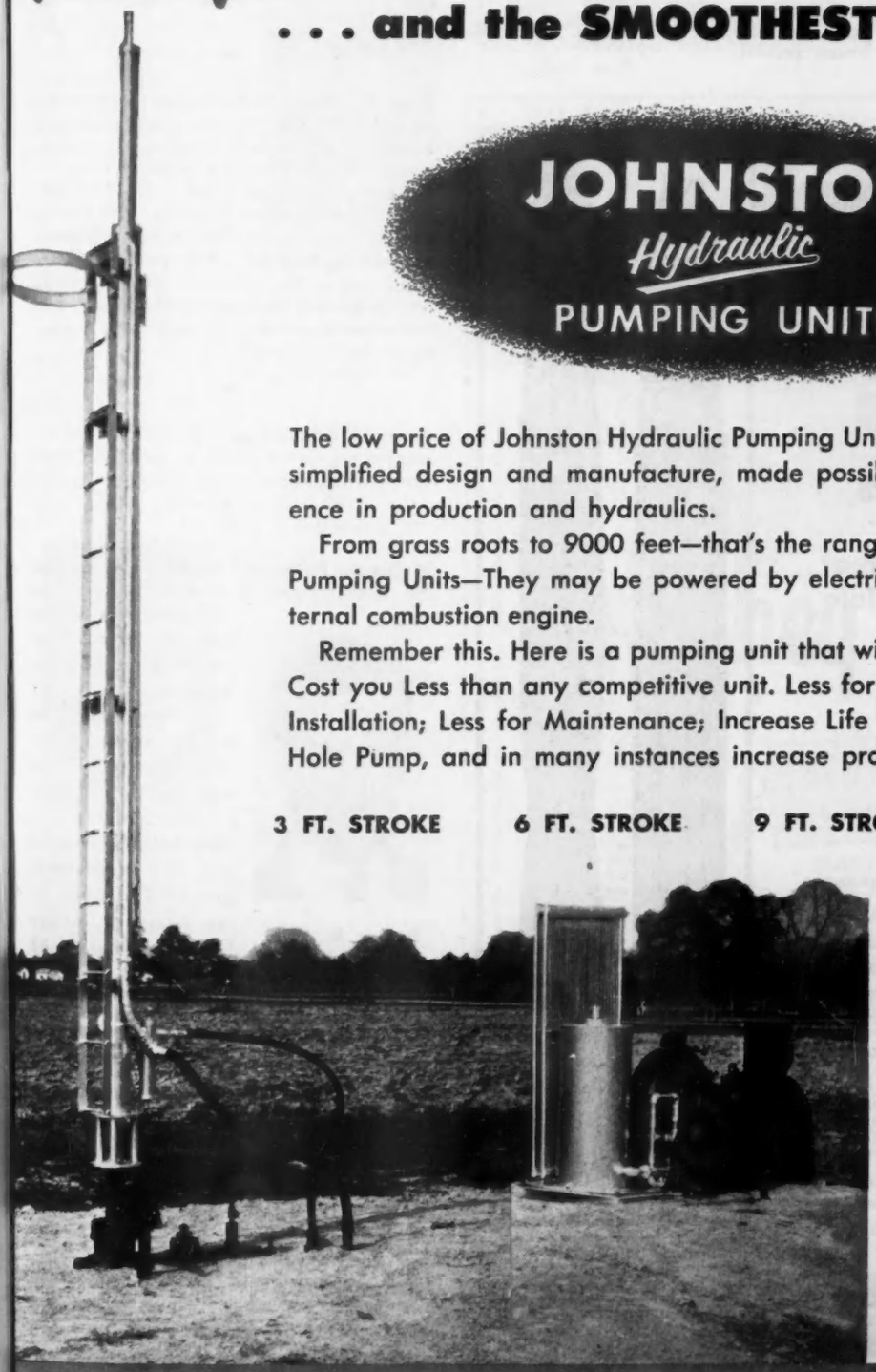

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Remember this. Here is a pumping unit that will SAVE YOU MONEY—Cost you Less than any competitive unit. Less for Transportation; Less for Installation; Less for Maintenance; Increase Life of Sucker Rods, Bottom Hole Pump, and in many instances increase production.

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manager in Brazil and Sicily. He will make his headquarters in Houston. Larkin has been assigned to the general offices in Waxahachie, Texas.

•

Burl Johnson has resigned as vice president and manager for **Whitmore Homebuilders, Inc.**, Tulsa, specialists in industrial housing for the oil industry. He has been succeeded by **Russell E. Renfrow.**

•

Godfrey J. Stier has been appointed industrial engineer of **Leschen Wire Rope Division, H. K. Porter Company, Inc.** He will be primarily responsible for the formulation of standard costs and incentive plans for Leschen's new wire-drawing mill which is currently under construction.

Clarence W. Hahn has been named production manager of the **Waukesha Motor Company.** Hahn has been associated with the company since 1944, when he started in the production department. Since that time he has been active in all phases of production work, including inventory, inventory control, stores control, ordering and scheduling of materials and final production scheduling. He succeeds **Glenn R. Evans**, retired.

Clarence W. Hahn

Burton J. Matteson is now associated with **D. T. (Mickey) O'Connor** in New York as export sales representative for the following companies: Shaffer Tool Works, Drilling & Service, Inc., M. J. Crose Mfg. Company, Inc., McKissick Products Corp., Orbit Valve Company and Frank Wheatley Pump & Valve Mfg. Matteson will be traveling regularly throughout South America.

B. J. Matteson

•

John F. Maher retired from active management of **Oil Center Tool Company**, Houston. Maher will continue to be associated with OCT in an advisory capacity. His successor as president is **W. Al Wolff.** Wolff was formerly western manager of FMC's John Bean division. **Jim Witovec** and **Fritz Richard** were re-elected vice presidents of the Houston firm, and **A. L. McMillan** and **Mrs. Edith M. Barnes** were re-elected treasurer and secretary, respectively.

•

Avery C. Adams has been elected chief executive officer of **Jones & Laughlin Steel Corporation**, Pittsburgh, Penn.

•

McNamar Boiler and Tank Co., announced the appointment of **Robert B. Allen** as vice president of the firm. In 1946, Allen became a test pilot for the Southern Aircraft Co. From there he moved to Dallas in 1951 where he took over the post of sales representative and later sales manager and vice president of the LPG division of the Squibb-Taylor Company. In 1955 he joined the Gas Equipment Co., and was affiliated with that company prior to his appointment as vice president at McNamar.

Robert B. Allen

•

Tom Conway was appointed director of manufacturing services of **Borg-Warner Corp.** Since 1954 he had been general works manager of the Lycoming division of Avco Corp. For 17 years, starting in 1931, Conway was affiliated with the Chevrolet division of General Motors, rising to the position of master mechanic. He was general manager of the four plants comprising the Hi-Q division of Aerovox Corp. between 1948 and 1954.

•

Karl H. Baessler has been appointed director of wire product development for the Colorado, Wickwire Spencer, and Pacific

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Die Forged . . . Completely Heat Treated They Drill More Hole for Less Cost

Made in Butler, Pa. . . . used 'round the world . . . SPANG BITS are BEST:

1. DIE-FORGED—gives uniform section from end to end.
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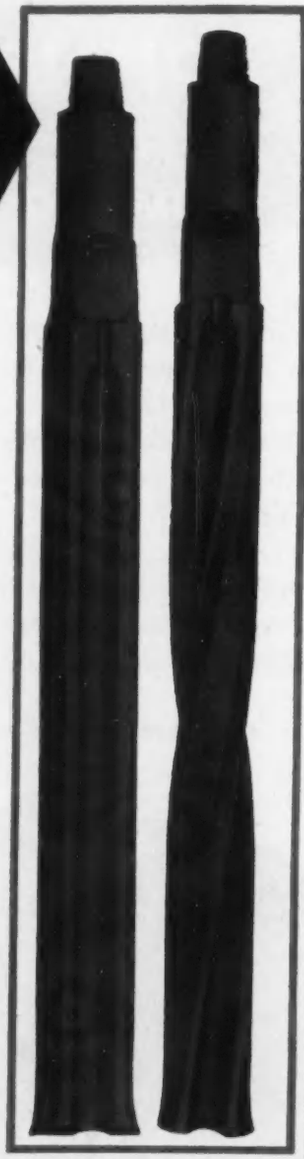
5. SEMI-DRESSED DRILLING ENDS—bits dress out to gage quicker with fewer heating
6. SELECT YOUR STEEL—made in high carbon and two grades of alloy steel—select the one best suited for your conditions.



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USE SPANG BITS—
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for YOUR OPERATION

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Coast Divisions of **The Colorado Fuel and Iron Corporation.** Baessler has been associated with CF&I since 1934 when he began work for the California Wire Cloth Corporation, now the Pacific Coast Division of CF&I, as a wire weaver. He has held various supervisory positions and since 1949 has been works manager of the Pacific Coast division.

•

C. C. Simmons has been named as director of sales and service for both **Franks Division, Cabot Shops, Inc.** and of the **Cabot Shops, Inc.** Simmons has moved to Pampa and assumed his duties in charge of sales for Franks well servicing units and drilling rigs and Cabot pumping units. He has been works manager of the Franks Division in Tulsa, in charge of the Shop, Engineering and Service departments. He has served in almost every capacity in the Franks organization, including the Field, Service department, Shop and in administrative positions.

C. C. Simmons

•

Frank M. Bateman was installed as president of the **Association of Oilwell Servicing Contractors,** at a quarterly directors meeting in the Shamrock-Hilton Hotel, Houston, recently. Bateman succeeds **J. C. (Calvin) Williamson.** Williamson resigned as president of the AOSC, after concluding a transaction in which he sold his interests in the Williamson Well Servicing Company, a firm operating out of yards in several towns in the Permian Basin. Bateman is president of Bateman & Whitsitt, Inc., Hobbs, N. M.

Frank Bateman

•

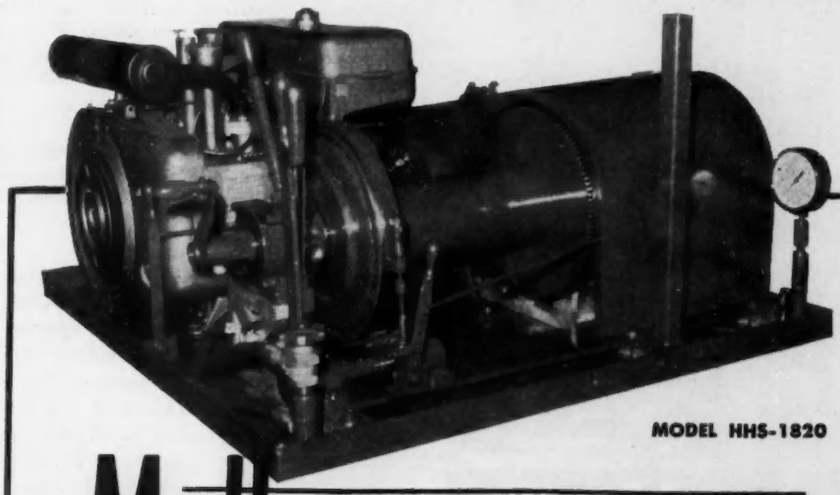
The Petroleum Supply Company announced the appointment of **T. M. Fontaine** as sales representative for "Hole-Hog" pump liners in southern Louisiana. During the past four years he has been a partner in the Petro-Plastic Engineering Company engaged in pipe line construction in Odessa, Texas. Fontaine will be located at New Orleans and will administer a territory including Baton Rouge, Houma, Grande Isle and Venice, La.

T. M. Fontaine

James N. Gregory has been elected vice president and general manager of the Petro-Mechanics Research division of **Borg-Warner Corporation.** This division operates a laboratory at North Hollywood, Calif, where a sonic oil well drill is under development. Gregory succeeds **Andrew W. Rose,** who resigned to become vice president and assistant to the president of the Byron Jackson Division of Borg-Warner. He was associated with Shell Oil Company from 1936 to 1952. In 1952 Gregory became vice president and manager of field operations for Terminal Drilling and Production Company. Since the first of this year he has operated in business independently as a consulting engineer in the field of mechanical engineering as applied to oil-field work.

Howard C. Swain has been named district manager of the **United States Steel Corporation's** Supply Division at Houston. He first joined U. S. Steel Supply division in 1948 as a telephone salesman in the Pittsburgh office. Later that year, he was made office manager and in 1951 was promoted to assist district manager there. In 1956 he was made manager of sales. Earlier this year he was named assistant district manager and manager of sales, Pittsburgh, his most recent post.

Howard C. Swain



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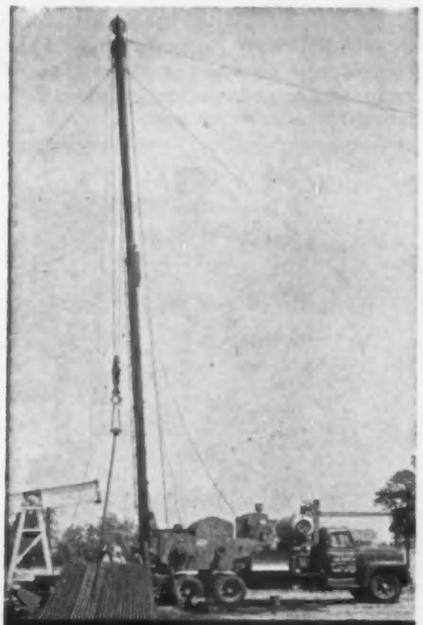
Designed to

SAVE YOU TIME



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Wichtex units save you job time, travel time, and downtime. Operators "swear by them" for fast, easy operation, great mobility, and easy maintenance. These units provide the capacity you require, at a reasonable price . . . plus remarkably long, economical life.

Available in 7 models for 2,000-foot to 12,000-foot capacity. All models can be furnished with spudding beams.

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Lloyd I. Fraser

C. G. Green, Jr.

Whitney Chain Company has appointed **Lloyd I. Fraser** as district manager of the company's Detroit office. Fraser succeeds **C. G. Green, Jr.,** who was recently appointed regional manager of the company's Southwestern territory, operating out of the Dallas field office. Fraser joined Whitney Chain in May, 1957. Previously, he had been associated with the Hanson-Whitney Company and Gates Rubber Company as a sales engineer. Before joining the Company in 1953, Green had been associated with several aircraft and power transmission manufacturers as a sales engineer.

•

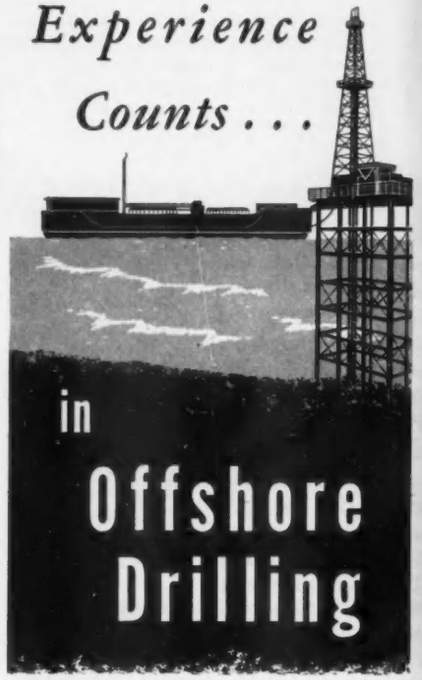
R. F. Faull, laboratory director, La Habra Laboratory of **California Research Corporation,** was appointed vice president of oil field research for the Standard Oil Company of California subsidiary. Faull succeeds **J. H. Thacher** who recently was elected president of Iran-California Oil Company with headquarters in London. **Alex Hildebrand,** manager of producing research at the La Habra Laboratory since 1954, has been named Faull's successor as director of the La Habra operation. In other administrative changes, **N. A. Riley** becomes assistant laboratory director and manager of exploration research and **R. E. Loeck** becomes manager of producing research, both at La Habra Laboratory.

R. F. Faull

•

The Elgen Corporation of Dallas announced the following promotions, assignments and office openings. **Norman Williams** has been named as head of the Perforating division in the Dallas main offices of Elgen. In addition to the Shreveport office where **Ernie Young** has been assigned as manager and **Custer Sokolosky** sales representative, Elgen announces two new offices to serve the Gulf Coast area more efficiently. In Natchez, Miss., **Dick Heard** has been appointed manager, and in Thibodeaux, La., **John Yerger** holds the same post. The opening of another office in El Dorado, Ark., has been announced also, with **Max Mitchell** assigned as manager. **Jim Moore** has been named as new manager of perforating operations in Wichita Falls, Texas. **Charles Franklin and Cliff Strozier** have been appointed as sales rep-

Experience Counts . . .



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EQUIPMENT

Reading and Bates operates two Levingston offshore drilling tenders with National Supply Co. Type 130 rigs, capable of drilling to a depth in excess of *20,000* feet in water *100* feet deep.

DEPENDABILITY

Reading and Bates is a dependable contractor with seasoned, experienced men operating their rigs. Contracts are fulfilled to the last letter.

KNOWLEDGE

Reading and Bates are specialists in offshore drilling. Their basic knowledge of offshore drilling problems, plus their wide experience, assures you of a job well done.

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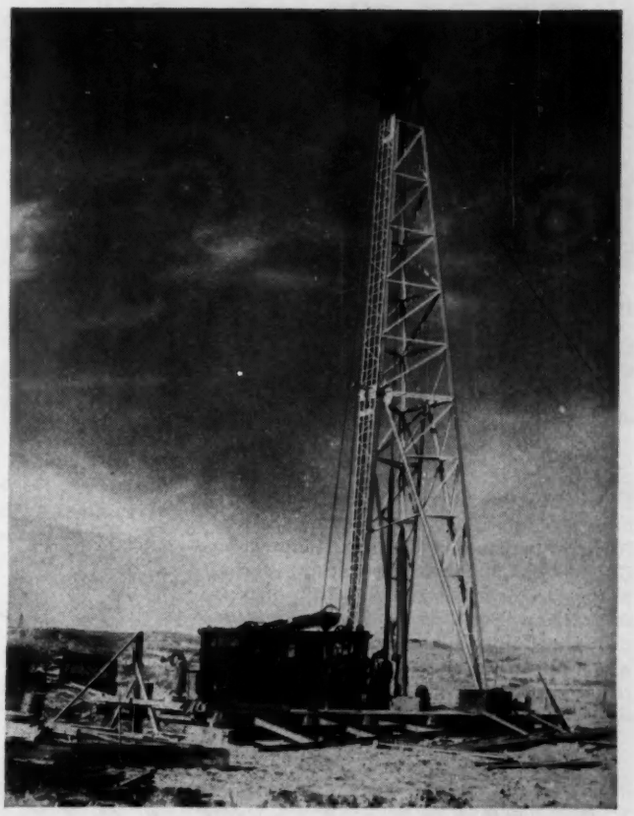
HEAVY-DUTY TRIPOD DERRICK
Lets You Move "Big Capacity" Around

For use with both 36-L and 48-L spudders, Bucyrus-Erie's heavy-duty tripod derrick has sufficient height and stability to handle casing loads up to 300,000 pounds when rigged for 10-part hoist. Completely raised, the derrick is 70′ 4″ high.

Despite the derrick's size, spudder mobility is retained. Erected in five easy steps, this derrick is easy to tear down and move. Each of the five units can be disassembled and transported separately. Look: 45557



36-L Top-to-bottom drilling to 3,500 feet. Servicing to 4,000 feet. Swings up to 5,000 pounds of tools.

48-L Top-to-bottom drilling to 6,000 feet. Servicing to 7,000 feet. Swings up to 6,700 pounds of tools.

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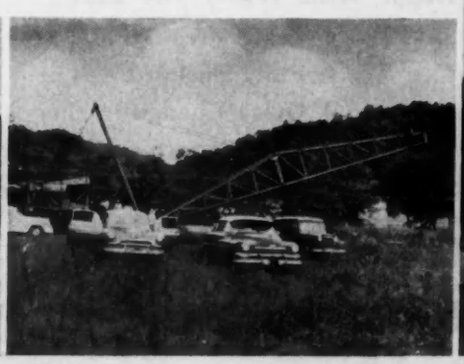
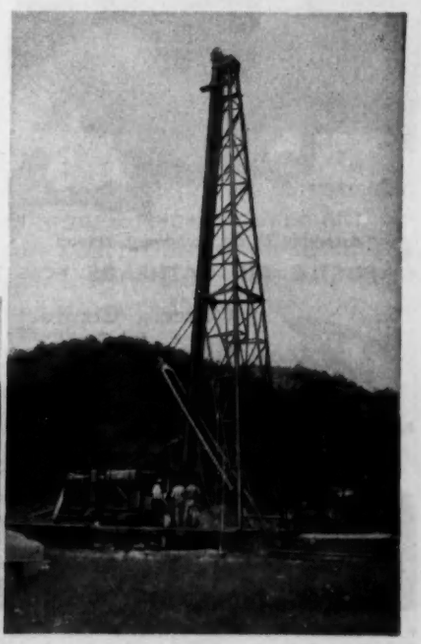
1. Derrick sections are assembled on the ground. Legs are hinged to the base and the gin pole is set in place preparatory to raising derrick.



2. Using the bull reel drum for hoisting, the derrick begins to rise. Hinged front lower section is pulled into place by the derrick hoist.



3. When the derrick is completely raised, the gin pole is removed and the front lower section is attached.

resentatives in Seymour, Texas, and Tulsa respectively.

•

Baker Oil Tools, Inc., has appointed **Ing. Hans Szepanek**, of Celle, Germany, as their technical representative for West Germany and Austria. He will also act in a similar capacity in such other European countries as time and circumstances permit. Szepanek spent seven years with Gewerkschaft Elwerath, in Germany, prior to joining Baker in May of this year. Since that time he has been training extensively in the U. S. at Baker's Houston and Los Angeles facilities as well as in the oil fields of Texas, California and New Mexico.

Ing. Hans Szepanek

•

Kelvin Sproule, formerly consulting metallurgist on the staff of **The International Nickel Company of Canada, Limited**, at Copper Cliff, Ontario, has been transferred to the Development and Research division at the New York office where he is associated with Inco's investigations concerned with the use of atomic energy effects in research. Sproule has been with International Nickel since 1937.

Byron A. (Bud) Haney has been appointed northwestern sales manager for Bucyrus-Erie Co. He takes over responsibility for the sales of all Bucyrus-Erie products in the states of Washington, Oregon, Idaho and Montana, the Territory of Alaska and the Yukon territory. He will maintain headquarters in Seattle, Wash. Haney started his career with the company in 1929. He was active in the manufacturing end of the business at both the Erie and Evansville plants until his appointment as a sales representative working out of Chicago in 1946. In 1950, he was transferred to New York, serving as a sales representative in the New England area.

Byron A. Haney

•

Charles L. Ward has been named assistant to the general manager for **Stewart & Stevenson** with headquarters in Houston. His most recent assignment with the company was in Dallas where he was executive engineer. In that capacity, he managed the Government Contracts division.

•

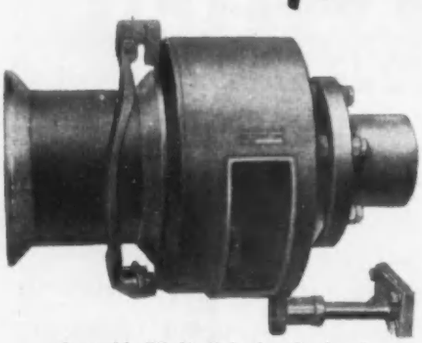
Ernest W. Polley has been appointed chief chemist for Youngstown district of the **Youngstown Sheet and Tube Company.** Polley succeeds the late **L. C. Flickinger.** He has been assistant chief chemist since 1947. Polley joined The Youngstown Sheet and Tube Company as an analyst in the Coke Plant laboratory between his high school and college days. He then served as a chemist in the Brier Hill Chemical Laboratory and became general foreman of that laboratory in 1929.

•

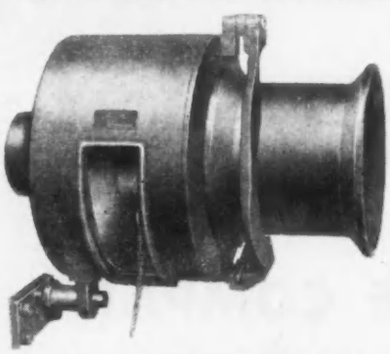
Hercules Motors Corporation announced some changes in their top management. **William L. Pringle**, who has been serving as director of engineering with the Long Manufacturing division of Borg-Warner Corporation, Detroit, has been elected president to succeed **John C. Keplinger** who is retiring from the top executive post but will retain his position as a director and will continue as an executive consultant. Pringle was also elected a director. **Henry H. Timken, Jr.**, chairman of the board of Timken Roller Bearing Company was elected chairman of the board. He succeeds **Charles Balough**, one of the founders of the company, who has been serving in that capacity and as a director since his retirement as president four years ago. Balough,

William L. Pringle

SPECIFY *Foster* CATHEADS when ordering your new DRAWWORKS



Assembly 37 Air Spinning Cathead



Assembly 24 Air Breakout Cathead

When you have a big job and you want peak performance from your catheads specify Foster AIR Catheads. These catheads have been used on some of the deepest wells in the world and have given 100% satisfaction.

With Foster Air Catheads the clutches are moved into engagement by air pressure behind a diaphragm. The line pull increases or decreases in proportion to the air applied. When the quick release valve dumps the air, clutch release is instantaneous. This is especially desirable and a great safety factor on fast moving shafts.

FOSTER AIR CATHEADS FOR THOSE WHO WANT THE BEST

A CATHEAD FOR EVERY NEED

- Precise Control.
- No Adjustments.
- Direct Diaphragm Actuated.
- Instant Disengagement.
- Crawl Free Drum.
- Fully Enclosed.
- Quick Change Jerkline.
- Peak Performance.

Foster Catheads, since 1926, "First Choice of the Industry"

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East-West Oil Tools C. A. Maracaibo & Anaco, Venezuela

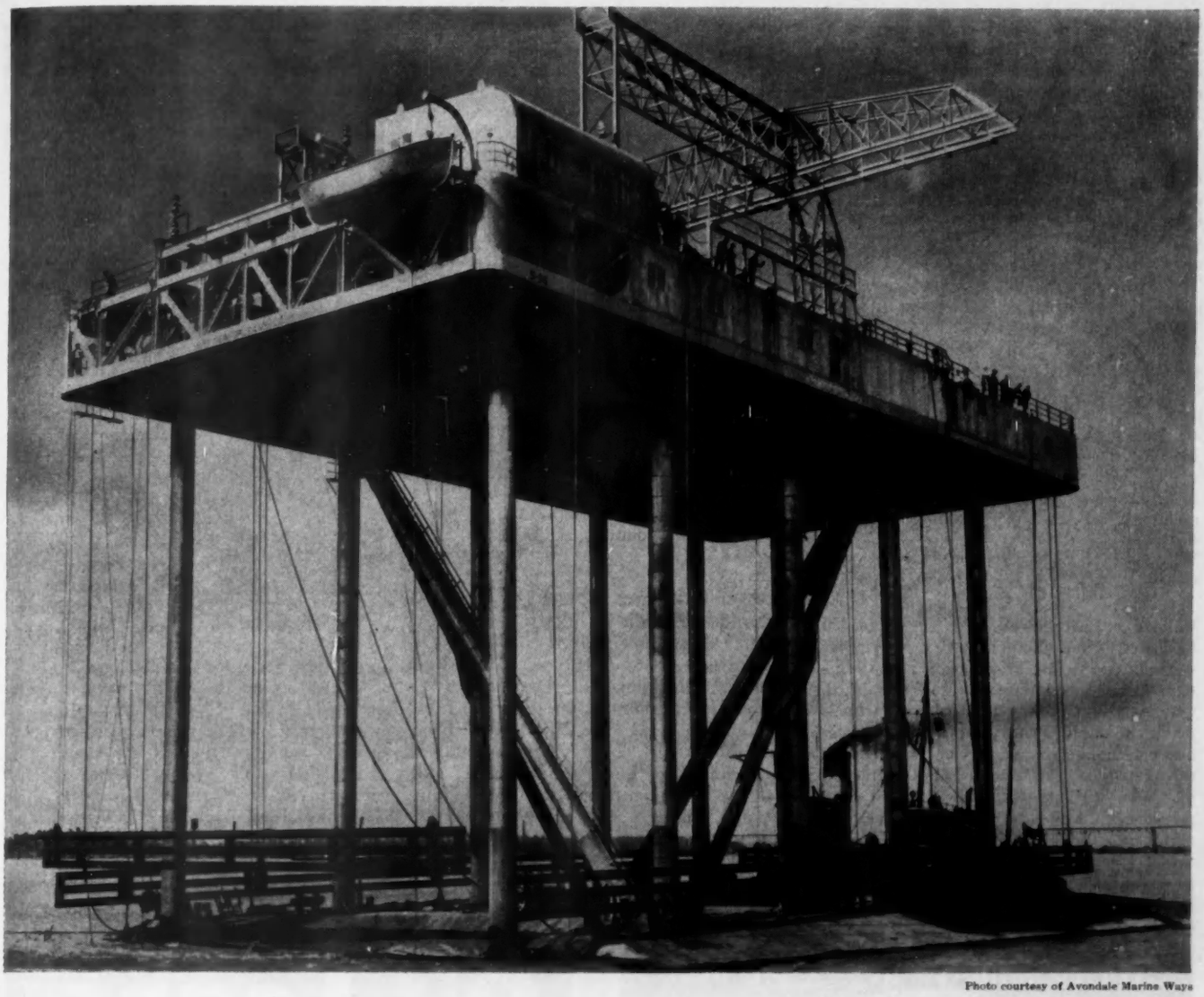

Photo courtesy of Avondale Marine Ways

Offshore rig . . . its giant legs are sheathed against corrosion with Monel

This is the S-55 . . . one of the largest offshore drilling rigs ever launched at New Orleans.

Its giant legs support the 150 x 190-foot elevated deck drilling barge . . . complete with crew quarters, gear, heavy machinery, 140-foot derrick.

They also take the brunt of the sea's constant attack . . . smashing waves, battering from floating equipment, the bite of corrosion.

Monel sheaths shield steel in 65-foot critical zone

The rig is sunk to bearing in waters 45 to 50 feet deep. Over all, some 65 feet of supporting structure may be exposed to splash corrosion . . . the kind most harmful to steel . . . where neither paints nor sacrificial anodes provide adequate protection.

In this critical 65-foot zone, welded 0.031-inch thick Monel* nickel-copper alloy sheathing covers and protects every square inch of the legs.

Monel alloy has proved by far the most practical way to control splash corrosion. It has been used on offshore drilling structures since 1949 and, more recently, on coastal radar "islands".

New developments in corrosion prevention come thick and fast. Before you finalize metal specs, talk them over with Inco's Development and Research Division.

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Improve your selection of metals for petroleum production equipment. Write today for the Inco booklet, "Metals to Make Petroleum Production Equipment Produce More."

The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

INCO NICKEL ALLOYS

who resigned as board chairman and a director, severed his connections with the company. **Walter F. Rockwell,** chairman of the finance committee of the Rockwell Manufacturing Company, is on the board of directors.

•

Carl P. Joyner was appointed district manager for the **Cardwell Manufacturing Company.** He will serve as district manager in the West Texas area and headquarter in Odessa, Texas. Joyner was formerly associated with the White Motor Company in Houston and Dallas as sales representative to major fleet accounts. He specialized in oil field transportation equipment. He was the co-owner of the Wichita White Truck Sales Company for the past three years.

Carl P. Joyner

•

Willard F. Rockwell Jr., president of **Rockwell Manufacturing Company,** has been named to the Manfacture and Industrial Development committee of the U. S. Chamber of Commerce. Rockwell, who is president of the Pennsylvania State Chamber of Commerce and a vice president of the Pittsburgh Chamber of Commerce, has been active in Chamber activities at the local, state and national level for many years.

Mid-Continent Supply Co. recently announced the promotion of seven men to field salesmen and one to city salesman. The promotions all are within the company's network of domestic stores. New city salesman at Odessa, Texas, is **E. J. Kreyenbuhl,** former field salesman at the same location. Assuming new duties as field salesmen were **H. R. Blakemore,** Magnolia, Ark.; **J. T. Cloyd,** Kermit, Texas; **G. E. McHugh,** Odessa; **M. B. Parker,** Laurel, Miss.; **R. W. Ramey, Jr.,** Hobbs, N. M.; **J. L. Reed,** Sundown, Texas; and **R. O. Womack,** Shreveport, La.

•

William Becker has been appointed district manager of the newly formed **National Sales Company,** California subsidiary of National Tank Company. Becker joined National at Odessa, Texas, where he served as field engineer for two years. Prior to his move to California he has been serving as district engineer in Abilene, Texas. General offices of National Sales, under Becker, are at 330 Commercial building, Los Angeles.

•

Dresser Industries Opens Expanded Zurich Offices

The formal opening of new and expanded offices was celebrated last week in Zurich, Switzerland, by Dresser A. G., European subsidiary of Dresser Industries, Inc. Dresser A. G., the Zurich-based firm, has sales and service representatives throughout the Eastern hemisphere, and also serves to coordinate the manufacturing and mining operations of Dresser Industries, Inc., in England, France, Germany, Holland, Italy and Greece.

Hosts for the Zurich opening were J. B. O'Connor, Reece Hatchitt, President of Dresser A. G., and Dr. Hans Berger, of the Dresser A. G. board of directors. Guests included representatives of Swiss and other European manufacturing, financial and petroleum interests.

•

William C. Brooks Named Head Of BJ's New Sales Department

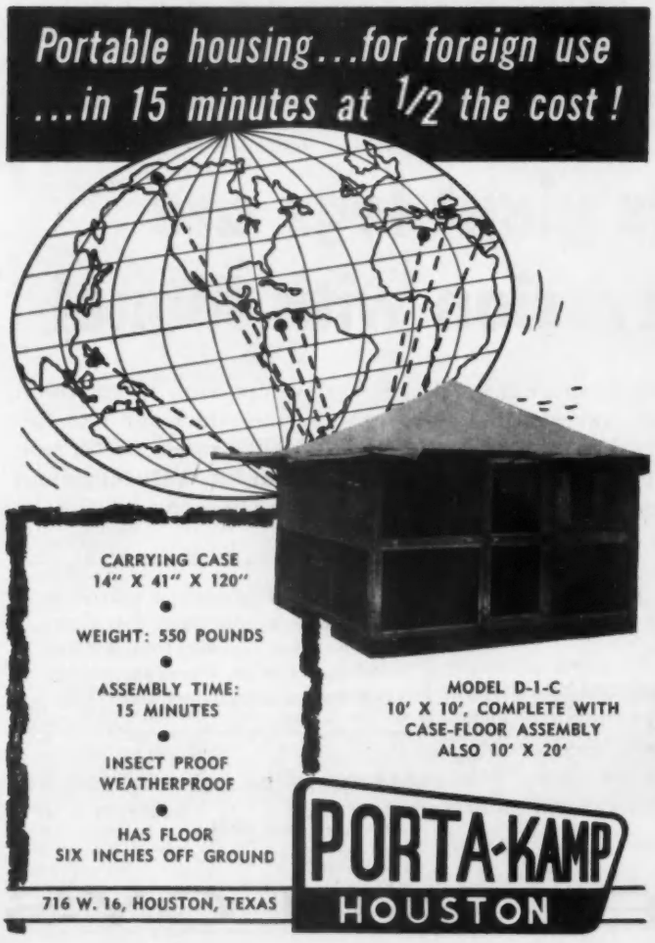
W. C. Brooks has been named to head Byron Jackson Tools' new Industrial Rubber Sales department in addition to his present duties as western regional sales manager for oil tools. According to the announcement, this new department will be concerned with three areas of sales expansion for the company's PB Rubber section:

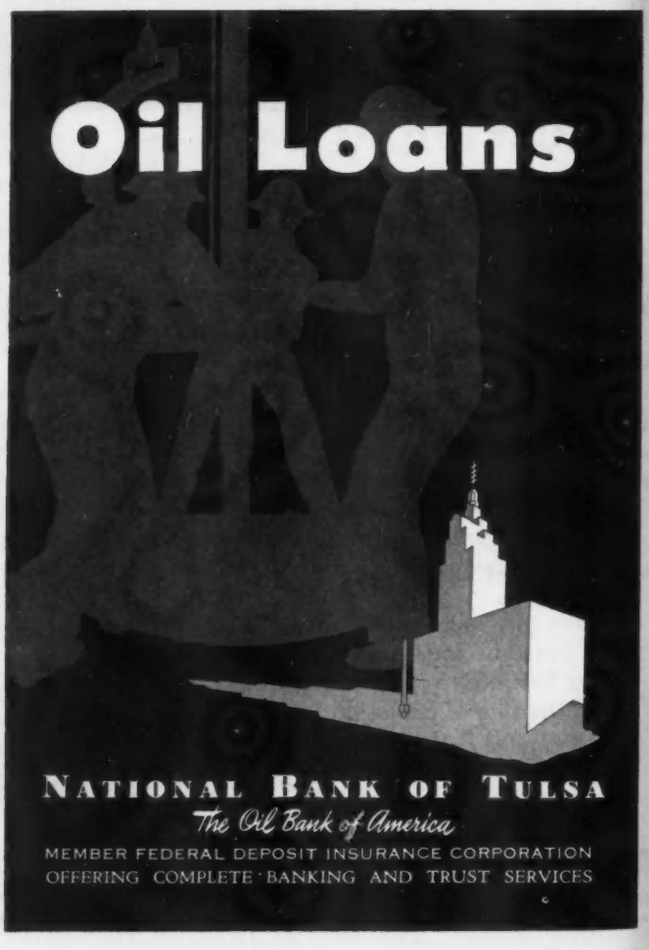
W. C. Brooks

1. Finding new markets and uses for current BJ rubber equipment or components now manufactured primarily for oil field use.

2. Developing new BJ proprietary products in rubber—such as the line of water-lubricated marine bearings now manufactured by the PB section.

3. Offering the complete services of a modern rubber plant to industry for solving special molded and bonded-to-metal rubber jobs.




Oil Loans
NATIONAL BANK OF TULSA
The Oil Bank of America
MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION
OFFERING COMPLETE BANKING AND TRUST SERVICES

HIGHEST WELL PRESSURE EVER!

—Certified by MARSH

Yes, 11,400 psi!

This was oil country drama at its best: bringing in the "2 Elue Roach" well in Union Oil & Gas Corporation's spectacular Lake Arthur Field at Jefferson Davis Parrish, Louisiana. The Marsh Gauge climbed to 11,400 psi; later reached 11,600 psi—highest shut-in tubing head pressure ever registered by an oil well, and by a good margin.

Only a few years ago oil companies were refusing to complete wells that threatened pressures of even 10,000 psi. But stronger casings, and techniques developed by Union in dealing with ever higher pressures in the Lake Arthur Field, had made "2 Elue Roach" a producing reality.

It took a lot of doing—a lot of programing and qualifying of materials—to bring in the Roach Well and the new era it foretells. So it is not surprising to see a Marsh Gauge at the top of the Christmas Tree.

Yes, wherever oil flows Marsh is at the top of the list. In the Mastergauge everything that can contribute to gauge accuracy and dependability has been brought to a higher stage of development:

—One-piece leak-proof construction of socket, tube and tip by the exclusive Marsh "Conoweld" process.

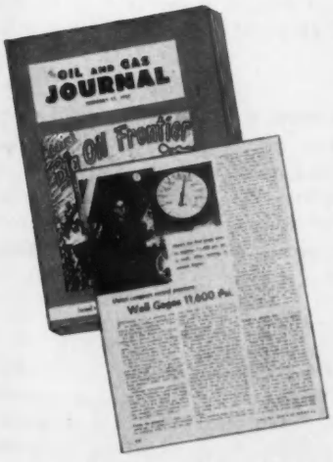
—Sturdy "Marshalloy" case of boiler-plate thickness steel; copper clad inside and out.

—Precision movement with unduplicated plus features like the "coined" sector gear.

—Stainless tubes and sockets available for any corrosive service.

—Finally, the famous Marsh "Recalibrator" to keep the gauge always accurate.

Ask for new catalog covering Marsh instruments.



An interesting account of the method of completing the "2 Elue Roach" will be found in the February 11 issue of Oil & Gas Journal. Depth of well is 15,461 ft. Well tested 190 bbl. of condensate and 6,375,000 cu. ft. of gas daily.

MARSH INSTRUMENT CO. *Sales Affiliate of Jas. P. Marsh Corp. Dept. K*
Marsh Instrument and Valve Co. (Canada) Ltd., 8407 103rd St., Edmonton, Alberta
Houston Branch Plant: 1121 Rothwell St., Sect. 15, Houston, Texas

MARSH GAUGES

"THE STANDARD OF ACCURACY"

GAUGES • WATER REGULATING VALVES • SOLENOID VALVES • HEATING SPECIALTIES

W. R. Wheeler, Jr., American Iron sales manager, discusses important product design changes with Claude L. Griffin, vice president and assistant to the president, M. G. McCool, president, and E. E. Rubac, executive vice president.

American Iron Holds Meeting To Spotlight New Products

American Iron & Machine Works Company recently held a special sales meeting in Oklahoma City, attended by 40 of their district managers and special representatives, for the presentation of new product information.

Films, slides and charts were used by the American Iron Engineering department in presenting data on the new products soon to be announced to the industry.

Todd to Build 15 Barges For National Lead Company

The Products Division of Todd Shipyards Corporation has been awarded a contract by the Baroid Division, National Lead Company, calling for the construction of 15 deck cargo barges, 110 feet by 30 feet by 7 feet. Delivery began in October. Todd's Products division is located in Houston.

Rolo Manufacturing Expands And Adds Four to Staff

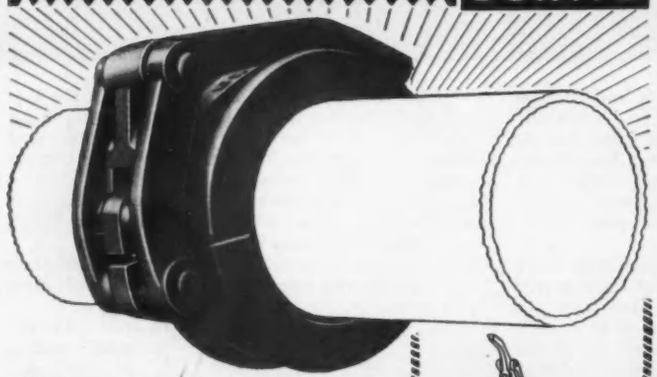
The appointment of a new director of sales and four additions to its sales and service staff, all in line with a current expansion program, has been announced by the Rolo Manufacturing Company.

The new director of sales is James L. Kepple. He has been with Rolo for ten years and will continue to serve in the capacity of secretary-treasurer of the corporation. Additions to the sales and service staff in different areas include two individuals and two companies—George Bradley, Ace Specialty Company, L. A. Christopher Company and A. W. (Al) Swenson. Bradley will sell Rolo equipment in the Lafayette, La., area.

The L. A. Christopher Company, with offices in Denver and Durango, Colo., will represent Rolo in the Rocky Mountain and Four Corners areas. L. A. Christopher and Steve Klimoski, both of the Christopher firm, have had many years of experience selling to oil companies.

The Ace Specialty Company now rep-

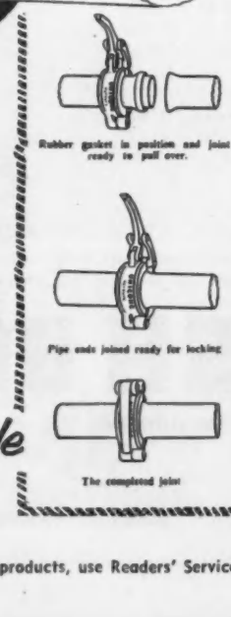
INSTANTANEOUS! JOINTS



A perfect seal in a matter of seconds

For temporary pipe lines 'Unicone' instantaneous joints are recommended. Comprising two parts only, they fasten with a "snap" ensuring a perfect seal in a matter of seconds.

For permanent or semi-permanent pipe lines 'Unicone' bolted type joints are usually employed and can be assembled far more quickly than any flexible joint giving positive anchorage.



'UNICONE' REGD
Flexible Joints for all Pipelines.
Leakproof. safe. reliable

THE UNICONE COMPANY LTD.
RUTHERGLEN • GLASGOW • SCOTLAND

Announcing Three Complete Locations to Serve You!

HOUSTON. Wayne A. Johnson, President, directs the company's activities from the Main Office in Houston. Mr. Johnson is well known in the cathodic protection profession and is the author of many technical articles in the field. P. O. Box 19177, Houston, Texas.

GREAT BEND, KANSAS. Harvey Fanshier, Mid-Western representative for Corrosion Rectifying Company is a graduate of Kansas State College with extensive experience in salt water disposal and corrosion prevention. Rt. 2, Great Bend, Kansas.

NEW ORLEANS, LA. James T. Condry, New Orleans representative, is a graduate Electrical Engineer in charge of evaluation, design, installation and materials sales for the Louisiana territory. He has wide experience in marine and offshore installations. 2322 Airline Highway, Kenner, Louisiana.

CORROSION RECTIFYING CO., INC.
5310 Ashbrook Phone MO 7-6659
P. O. Box 19177 • Houston, Texas

resents Rolo in the Abilene area under the direct supervision of Rolo's West Texas representative, J. W. Massey, Jr. Swenson will represent Rolo in North Texas and the Panhandle areas of Texas and Oklahoma.

U. S. Nuclear Industry Furnishes Safety Devices for French AEC

Tracerlab, Inc., announced through its Foreign department that it was completing shipment of a large order for radiation protection devices to be used by the personnel of the French Atomic Energy Commission at its various installations.

J & L Supply Appoints Crawford Panhandle Sales District Head

The opening of a new oil field supply store in the Panhandle Sales district of Jones & Laughlin Supply division, headquartered in Tulsa was announced.

J. J. Crawford, formerly manager of the Firm's Edmonton, Alberta, Canada, store, has been appointed local store manager of the new store; S. J. Payne and E. J. Pierson have been assigned to the new location as sales representatives. Assisting Crawford in store operations are K. C. Sierer and R. C. Small.

The Liberal, Kansas, store will be under the over-all supervision of H. U. Everett, district sales manager, headquartered at Amarillo, Texas.

Among the honor guests at the opening of Reed N. V.'s Holland plant was the burgomaster of the city of Leiden, F. H. Van Kinschot, second from right. Shown, from left, are R. G. Hamaker, Mrs. Hamaker, Mrs. Kinschot, Mrs. F. L. Tyler, Van Kinschot and F. L. Tyler, manager of Reed, N. V.

Reed Roller Bit Dutch Subsidiary Holds Ceremonies for New Plant

Formal opening ceremonies of the Reed Roller Bit Company (Nederland) N. V. rock bit manufacturing plant at Leiden, Holland, were held recently. Reed N. V., wholly-owned subsidiary of Reed Roller Bit Company of Houston, is this company's first oil tool manufacturing expansion outside the U. S.

Production of the new Reed "Y" series three-cone bits, by the new plant will supplement Reed's Houston production for world-wide distribution. Proximity to European and Middle East markets will speed delivery of Reed bits to those areas. This new facility will permit operators to purchase Reed bits for guilders or other currencies which can be exchanged for guilders.

R. G. Hamaker, president of Reed, was in Leiden for the ceremonies. F. L. Tyler, formerly California sales division manager for Reed, is the manager of Reed N. V., and John Workman, formerly an engineer for Reed in Houston, is co-manager.

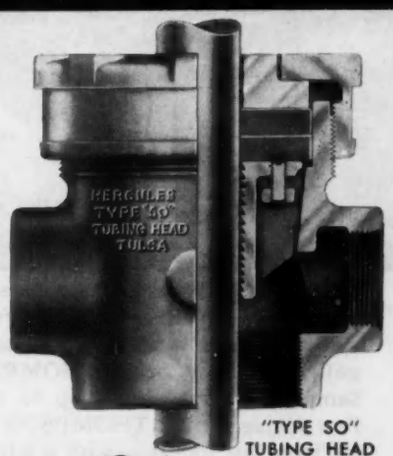
Robert G. Atkins to Manage Whitney Chain Department

Robert G. Atkins has been appointed manager of a newly created Marketing department for Whitney Chain Company and Hanson-Whitney division, Hartford, Conn. The new Department will function

there's a Hercules tubing head

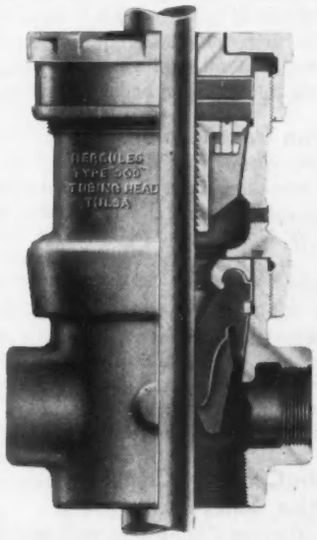
TO FIT YOUR REQUIREMENTS...

HERCULES "Type SO" Tubing Head is particularly suited for pumping due to compactness (only 12½" high). Stripper rubber can be used in body for running or wiping tubing. Also ideal for intermittently flowing wells.



"TYPE SO" TUBING HEAD

HERCULES "Type SO" and "SOS" Tubing Heads are the favorite of successful operators because of their simplicity, ruggedness and ease of operation. Available in 4½" OD to 7" OD Casing Sizes to suspend 2", 2½" or 3" tubing. Constructed from pressure cast steel and tested to 4,000 PSI. Slips are hinged for ease of installation and positive alignment.



"TYPE SOS" TUBING HEAD

HERCULES "Type SOS" Stripper Tubing Head is unsurpassed for use in well servicing operations as well as on flowing wells. It consists of a HERCULES "Type SO" Tubing Head with a bowl and Neoprene Tubing Stripper.

HERCULES TOOL Company

"MANUFACTURERS OF OIL FIELD EQUIPMENT SINCE 1924"

GENERAL OFFICES AND PLANT TULSA, OKLAHOMA

Available through all supply stores: Export Representative: Oil Field Equipment Co., Inc., 30 Church Street, New York 7, N. Y.

as a centralized market fact-finding and recommending agency for both company divisions.

Atkins joined Whitney Chain Company in 1941 and has been serving as advertising and export sales manager for the past 12 years.

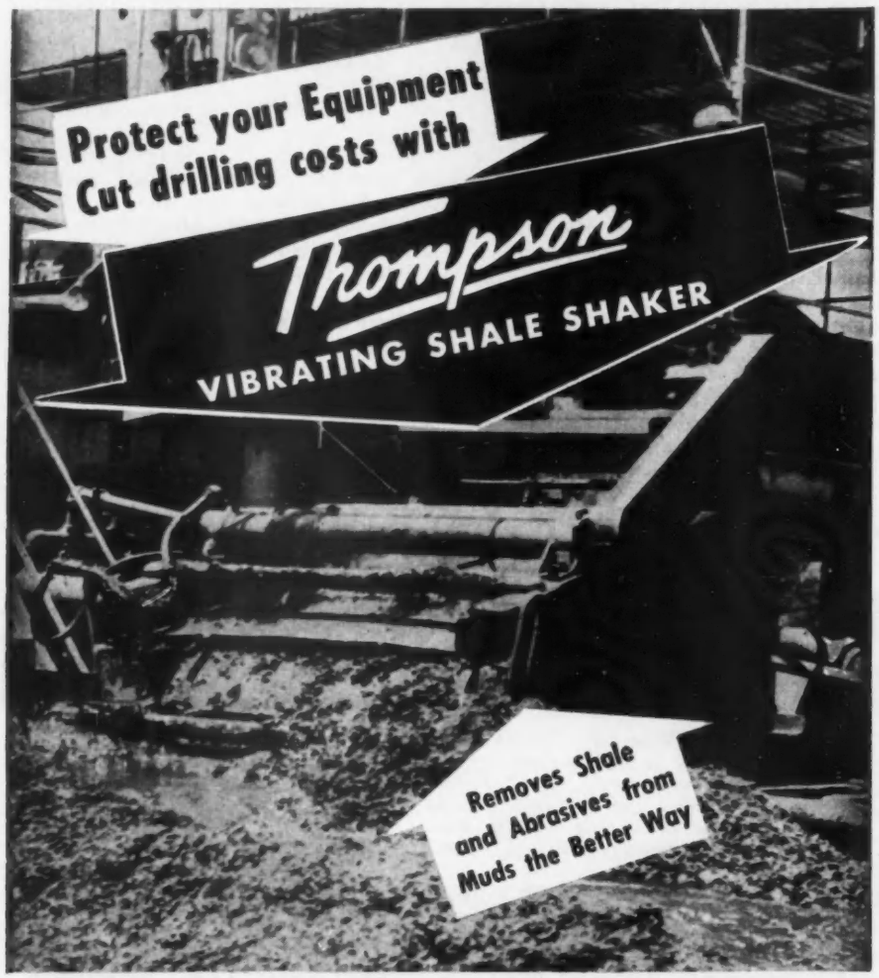
Harrisburg Sales & Service Forms Three New Districts

Promotion of six men and expansion of field service by Harrisburg Sales & Service, Inc. has been announced.

Harrisburg has formed three new sales districts at Houston, Odessa, Texas, and Houma, La. R. T. Stewart, former Houston district manager, was named to head the new Houston sales district; Jack Floyd was promoted from sales engineer to South Louisiana district manager; and T. E. Nesky was named to head the West Texas district. Nesky formerly was a sales representative in Odessa.

Assuming duties as sales engineer at New Iberia, La., is E. O. Hudnell, who was promoted from field salesman at Houston.

Also taking over new sales positions are W. E. Smith who was named salesman at Andrews, Texas, and J. A. Brookman, who was promoted to field salesman representing Harrisburg in north Texas, southern Oklahoma and the Panhandle, with headquarters in Oklahoma City.

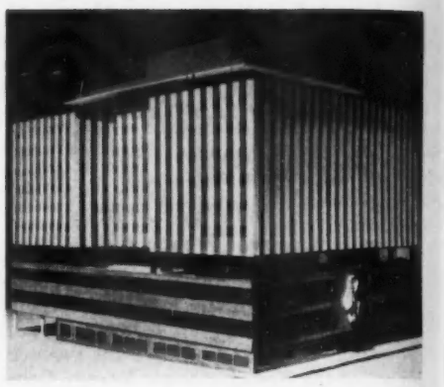

Protect your Equipment
Cut drilling costs with
Thompson
VIBRATING SHALE SHAKER
Removes Shale and Abrasives from Muds the Better Way

Separation of shale and abrasives from drilling muds is an important *must* for an effective, time-conserving, money-saving drilling job. Reclamation of mud is vitally important. No matter what the mud flow or well depth may be, a THOMPSON Vibrating Shale Separator and Sample Machine stands up to meet any demand. It's field proven! *You get clean mud.* THOMPSON Separators are self-motivated... making tools last longer... with a minimum of re-tooling and restoration of mud solution.

A THOMPSON Separator is your surest bet.. for shallow, medium and deep wells. The dependable Sample Machine works simultaneously with the Separator, giving a foot-by-foot mud analysis with specimens. *Write for Free Folder.*

THOMPSON TOOL CO.
IOWA PARK, TEXAS

SOLD ONLY THROUGH SUPPLY STORES



The new Continental-Emsco Company will have an office area of 60,000 square feet, occupying three floors of the enlarged building. The district offices of the Youngstown Sheet and Tube Company will also be in the new building.

Continental-Emsco To Move Into Larger Dallas Offices

Continental-Emsco Company has announced plans to relocate its home office in Dallas into newer, larger quarters. The move, slated for the latter part of 1958, will headquarter the home offices of the oil field supply and manufacturing company in the Mercantile Commerce Building. The company is a division of The Youngstown Sheet and Tube Company.

Located just a few blocks east of Continental-Emsco's present location, the Mercantile Commerce Building occupies an entire city block. The construction project scheduled for the building, includes the addition of eight floors as well as refacing and remodeling the present three floors.

Good-All Electric Appoints Colby, Inc., Export Agent

Colby, Inc., of Houston has been appointed export agent, except for Venezuela, Canada, Alaska and Hawaii, for the rectifier section of the Electrical Mechanical division of Good-All Electric Manufacturing Company, Ogallala, Neb. The addition of the Good-All rectifier will complete their oil field equipment line, which includes oil and gas pipe line, oil rigs, rock bits and applied equipment.

American Iron Appoints Exclusive Agent in Trinidad

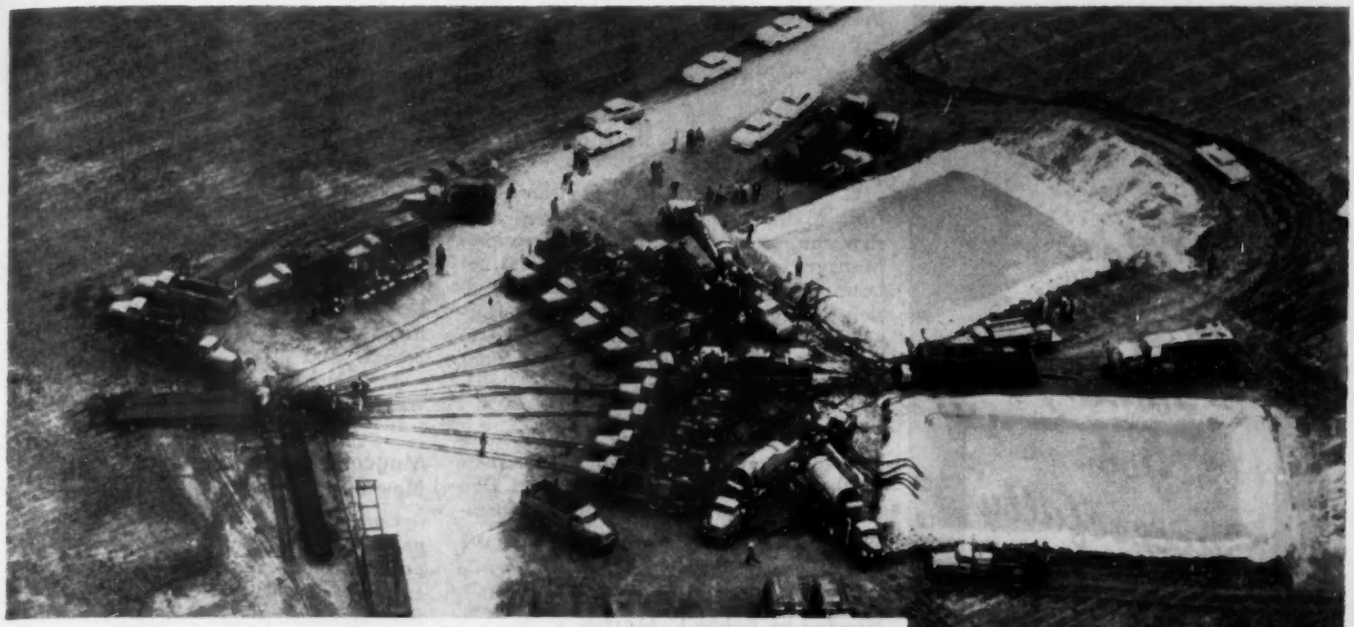
The American Iron & Machine Works Co., Inc., announces the appointment of Masons & Company, Ltd., Port of Spain, B.W.I., as their exclusive agent in Trinidad.

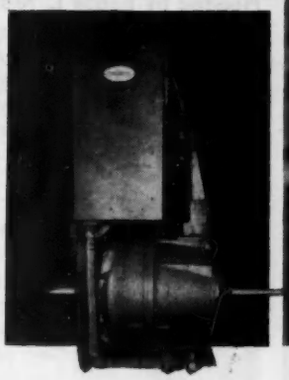
John Rooks, representing Masons & Company, Ltd., recently spent ten days at the main offices and plants of American Iron in Oklahoma City, to observe the latest manufacturing techniques on oil field equipment by this company.

Western Company Combines Operation, Sales Departments

The Western Company, well servicing concern with headquarters in Midland, Texas, has consolidated its operations and sales departments.

Sales and service now will be controlled





New fracturing record set with torque converter drives

When a large southwestern oil company called in Dowell Incorporated, Tulsa, for fracturing a Borden County, Texas, oil well, 41 Dowell engineers arrived prepared for a major job.

With 29 pieces of equipment, two newly built polyethylene film-lined pits, 329,000 gallons of water and 225,000 pounds of sand, the men pumped a staggering 3000 gallons a minute into the well at 3500 psi. The result was that Dowell easily broke its own previously established world fracturing record.

To handle this tremendous job, Dowell's equipment had to produce 15,000 gross hp and 6250 hydraulic hp . . . but Dowell had the equipment to produce it. For one thing, each fracturing unit was equipped with a 1500-hp engine. For another, each engine drove through a Twin Disc 16,000 Series Three-Stage Torque Converter. Thus regardless of the varying loads and pressures, the torque converters permitted the engines to operate in their most efficient rpm range and produce rated hp. They also provided more efficient operation because the power units were indirectly compounded by the load.

This, however, is only one of many oilfield applications where Twin Disc Torque Converters really prove their worth. Drawworks, rotary tables, mud pumps—whatever your power application problem, you'll find Twin Disc Torque Converters a simple but effective solution to cutting operating costs and producing greater profits. The smooth, shock-free flow of power through the fluid drive increases machinery life, reduces engine wear and minimizes downtime. Full engine hp can be maintained regardless of load . . . and torque multiplication up to 6:1 (three-stage) is available whenever the load demands it.

Take advantage of the many cost-saving features offered by Twin Disc Three-Stage or Single-Stage Torque Converters. See your local equipment dealer or Twin Disc representative or write to Twin Disc Clutch Company, Racine, Wisconsin; Hydraulic Division, Rockford, Illinois.

TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES

TWIN DISC
Torque Converters

For more data on advertised products, use Readers' Service Cards, last page.

Pioneers of successful magnetic fishing tools and methods

More Magnetic Fishing Jobs Successfully Completed With K & G Tools and Methods than with all other magnetic tools combined...

for satisfaction use

K & G MAGNETIC FISHING TOOLS
DRILL PIPE JUNK SHOT
ADJUSTABLE CORE BARREL MAGNET

Available in popular sizes from most major fishing tool companies. Be sure to see that it's K & G . . . the only company licensed to manufacture under U. S. Patent No. 2,668,077.

Call, write or wire for quotations on use in your area.

K & G
OIL TOOL and SERVICE COMPANY, Inc.
2703 Sackett • Houston 6, Texas
JA 2-5436

7345

by the new Operations-Sales department under management of Walter Beadle, Midland, vice president of the company. The consolidation resulted in the forming of the Oklahoma and Midland divisions, with respective headquarters in Oklahoma City and Midland.

C. E. Woolridge has been transferred from Midland to Oklahoma City as division manager of sales and operations. Manager for the Midland division has not been named. In Oklahoma City as division sales manager is W. W. Wilson. Harold Parsons was moved from Midland to Oklahoma City as division operations manager. Both men will report to Wooldridge.

Charles Simmons, former regional manager of operations in Midland, is the new Midland division sales manager, and Don Wolters is new Midland division operations manager.

McCullough's Colorado Branch Headed by Bobby L. Martin

McCullough Tool Company established a service branch at Cortez, Colo.

Bobby L. Martin, branch manager, formerly in charge of operations at the McCullough Tool Company Hobbs, N. M., branch, is in charge of operations at the Cortez branch which will provide 24-hour electric wire line services to the oil industry in the area. Martin has had over ten years experience with McCullough Tool Company as sales representative and branch manager.

Bobby L. Martin

McCullough electric wire line services available will include radiation well logging, bullet and jet perforating, magnatector (free point finder), jet back-off tools, bridge plugs, chemical tubing cutters etc.

Ernie Graves Co. to Represent Win-Well in Oklahoma Territory

The appointment of the Ernie Graves Company of Tulsa as sales representative for Win-Well Manufacturing Company, Los Angeles, has been announced.

Graves also represents J. F. Pritchard & Company of California, Conoflow Corporation, Brooks Rotometer, Weston, Maloney and King Engineering Company. They will serve the Oklahoma territory for Win-Well.

Parkersburg Opens Branches In Liberal and Farmington

Establishment of two new branches have been announced by the Parkersburg Rig and Reel Company. A new branch at Liberal, Kansas, will serve the Texas Panhandle, western Oklahoma and southwestern Kansas. J. W. Bower has been named branch manager.

At Farmington, N. M., a branch has been set up under the managership of W. H. Clayton to serve the Four Corners area.

Other personnel transfers and promotions in the Production Equipment division included the transfer of B. G. McDonald from Odessa, Texas to Hobbs, N. M., where he will be branch manager, succeeding the late W. D. Moore. Others named to be branch managers were T. J. Daniels at Shreveport, La.; J. S. Hunter at Lafayette, La.; B. B. Rister at Corpus Christi, Texas; A. F. Kreutzer at Oklahoma City; J. L. Simmons at Great Bend, Kansas; and B. D. McClellan at Houston.

J. L. Lamp, salesman at Denver, was transferred to Midland.

Magcobar Expects to Finish New Building in One Year

Construction began recently on the expansion of the Magnet Cove Barium Corporation office and laboratory building in Houston. Target date for completion of the expansion is one year after construction begins.

The proposed expansion will add 33,500 square feet to the Magcobar facility and more than double the building's present 29,000 square feet. Another 4000 square feet will be added to an adjacent garage building.

Foundations for the two-story section of the expansion will be constructed to accommodate eight stories, should the addition of six more stories be required in the future.

National Supply Establishes Ninth Store in Canada

The National Supply Co. has opened its ninth oil field supply store in Canada, at Whitecourt, Alberta, with C. L. Bentley as manager, under supervision of Robert M. Borden, district manager of the Northern Alberta district.

F. J. Hearty & Company Changes Name to Paul Bradfield & Co.

Paul Bradfield & Co. is the new name of the Los Angeles manufacturers representatives firm formerly known as F. J. Hearty & Company. Coincidental with changing its name the firm moved to new quarters at 864 Robertson Boulevard, Los Angeles.

The firm is sales representative for Edward Valves, Inc., Subsidiary of Rockwell Manufacturing Company, and other manufacturers supplying equipment to the power, industrial, petroleum and marine fields.

Paul Bradfield, manager of the Hearty firm for a number of years, is head of the new firm.

Atkins, Kroll to Represent BJ Oil Tools in Philippines

Atkins, Kroll & Co. has been appointed sales representative for Byron Jackson Tools, Inc., in the Philippines. Atkins, Kroll will handle the full line of BJ tools, including hooks, tongs, slips, spiders, power tools, rubber goods and other drilling equipment.

SQUEAKS from the BULLWHEEL

"Any suggestions? Not you two—"

WORLD OIL

Please!

"I feel a little chilly, Joe. Will you run inside and get me Jack Brown?"

Ah, Memories!

"May I come in?" he said. "It's the room I had when I was in college in '09."

"Yes, sir," he said, lost in reverie. "Same old window. Same old view of the campus. Same old closet." He opened the door. There stood a girl, greatly embarrassed.

"This is my sister," the student quickly said.

"Yes, sir, same old story."

Two of a Kind?

Irate golfer: "You must be the world's worst caddie!"

Caddie: "Hardly. That would be too much of a coincidence."

A Super Colossal

"Have you read Webster's Dictionary?"

"No, I'll wait until they make it into a movie."

Amateur Medic

A young lady in the waiting room of an airport was crying steadily. Seeing her tears, a young man came over and tried to soothe her. He put a comforting arm around her and talked to her. When she continued to weep, he squeezed her tighter.

"Isn't there anything I can do," he asked, "to make you stop crying?"

"I'm afraid not," the girl sobbed. "It's hay fever. But please keep on trying."

Fetch Me a Drink

A mountaineer gave two visitors permission to hunt on his land. As they set out, he told them, "You'll find a still 'round t'other side of the mountain, and I'd be obliged if you'd bring me back a jugful."

At the end of the day, the pair stopped at the still, filled a jug but were barely on their way again when a bullet whistled over their heads. Pounding at top speed down the path to the mountaineer's cabin, they rushed in and panted that his still was being raided.

"Boys," he replied, as he hastily shut the door behind them, "I plumb forgot to mention, that ain't my still."

Too Honest

A local employment application form includes a question, "Have you ever been arrested?" On the following line, for the benefit of those whose answer is "Yes," is the question "Why?"

One truck driver applicant answered the first question, "No" and, after the second wrote, "Never got caught."

Stinging Squelch

An actress at a party, seeing an authoress whom she disliked, went over to congratulate her on her latest book.

"I enjoyed it, my dear," she said. "Who wrote it for you?"

"I'm glad you liked it," replied the authoress. "Who read it to you?"

Personal Question

"Do you keep stationery?' 'he asked the pretty girl behind the counter.

"Only up to a point," she giggled. "Then I go all to pieces."

Mother, Mother!

A woman divorced her husband and obtained custody of their 12-year-old son. Then she remarried and her ex-husband was somewhat concerned about the boy. "How do you get along with your stepfather?" he asked the lad.

"Fine," said the youngster. "He takes me swimming every day. We go out to

MERCOID®

MERCURY SWITCH EQUIPPED

PRESSURE CONTROLS

FOR SPECIAL APPLICATIONS

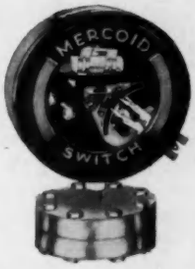
Low Operating Pressure—High Over-Range Protection

● EXAMPLE APPLICATIONS

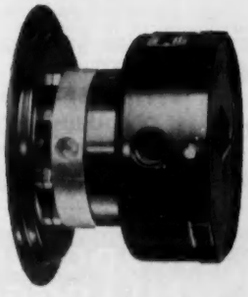
1. Provide low suction protection on pumps where suction pressure may go to very high line pressures (up to 2,500 psi.)

2. As an interlock to prevent a door to a pressure chamber from being opened until the pressure has dropped to atmospheric pressure (1" H2°) with over-range protection to 600 psi.

● TWO SERIES AVAILABLE



Series DA-900: Bourdon tube operated. Over-range protection to 2,500 psi. Operating ranges 0-60 psi; 0-100 psi; 0-150 psi; 0-300 psi.



Series CP: Diaphragm operated. Over-range protection to 600 psi. Operating ranges 1"-60" pressure or 1"-60" vacuum.

Both types available in various style cases-

SEND IN YOUR CONTROL PROBLEM OR WRITE FOR BULLETINS CA-21 & CA-1P

THE MERCOID CORPORATION
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For more data on advertised products, use Readers' Service Cards, last page.

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Since 1922
PETROLEUM ENGINEERS
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RESERVOIR ENGINEERING
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WORLD OIL

"I'm 50 percent in love with you, Roger, since your oil wells are 50 percent dry."

the lake and he rows me out to the middle and then I swim back."

"Isn't that a long swim for a boy of your age?" asked the father.

"Not too bad. Really, the only tough part is getting out of the bag."

Keep It Under Cover

"But you don't understand," explained the coed to the usher at the college play as he led her down to the orchestra aisle, "I have a box seat."

"Just keep your coat on," the usher advised, "and no one will notice it!"

Snare the Profit

Young Andersen and old Petterson had groceries in the same block. Eggs were the subject of their frequent price wars, with Andersen one time lowering the price of the eggs by several ores. The next day Petterson had met the price, so the third day Andersen lowered the price another ore.

This pattern continued until finally Andersen went to the older man in despair and said, "I surrender. We've both been selling eggs at a loss for so long."

"Not I," laughed Petterson. "You see, I've been buying my eggs from you."

Economics

Nowadays, when people speak of the higher things of life they might be referring to food.

It's Bound to Come

"And now, gentlemen," continued the congressman, "I wish to tax your memory."

"Good heavens," muttered a colleague, "why haven't we thought of that before?"

One of the Jones Boys

Page Boy: "Call for Mr. Niedlspronstrevnok, Mr. Niedlspronstrevnok."

Mr. N.: "What's the initial, please?"

Fringe Benefits

What the modern worker is fighting for is a five-day weekend.

Helpless

"Dad," asked the small boy, "why is a man allowed to have only one wife?"

"My son," replied the father, "when you are older you will realize that the law protects those incapable of protecting themselves."

A Thin Line

There are two kinds of women—those who wish to marry, and those who have not the slightest desire not to.

In Need of Toupee

Two ladies were discussing what they would wear to the country club dance.

"We're supposed to wear something to match our husband's hair, so I'm going to wear black," said Mrs. Johnson. "What will you wear?"

"Goodness," gasped her companion, "I don't think I'll go."

Definition

A jeep is a pint-sized truck with a built-in chiropractic treatment.

Believe Me

"I want you to know, my dear, you're the first girl I've ever made love to," he said as he shifted gears with his feet.

Someone You Know?

Boss (to new office boy): "Is there anything you can do better than anyone else?"

New office boy: "Yes, sir! Read my own handwriting."

Turn About

A race track is the only place to find windows that clean people.

Like Father; Like Son

Father: "Get up, Joe. When Abraham Lincoln was your age, do you know what he was doing?"

Joe: "No, I don't, but I know what he was doing when he was your age."

Too Late

By the time some men have money to burn, the pilot light has gone out.

On Pins and Needles

A visitor asked the sword swallower to demonstrate his art. He picked up some pins and needles and swallowed them.

"But," protested the visitor, "Those aren't swords . . ."

"I know," was the reply, "but I'm on a diet."

Let Well Enough Alone

Two women were comparing notes about their husbands.

"Pearl," said one, "who do you think is the laziest—your husband or mine?"

"I'm not guessing," the other replied. "Things are bad enough without starting any contests."

Definition

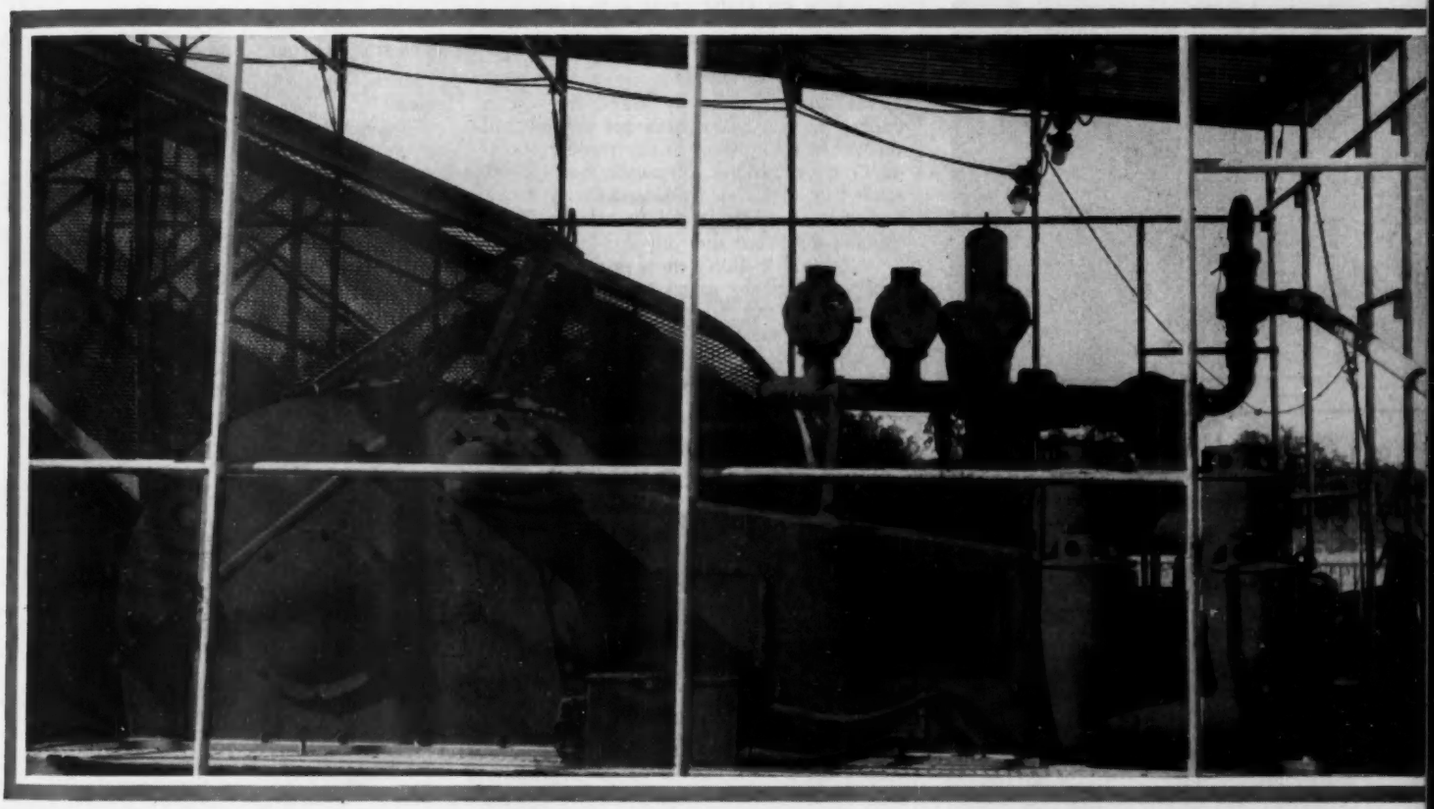
Fathers are what give daughters away to other men who aren't good enough for them. So they can have grandchildren who are smarter than anybody's.

"All I Did Was . . ."

Two Texas ranchers, in Chicago on business, were invited to attend a masquerade ball. On their arrival, one of them spied a girl masquerading as a map of

POWER SLUSH PUMPS

are an important part of the drilling team!



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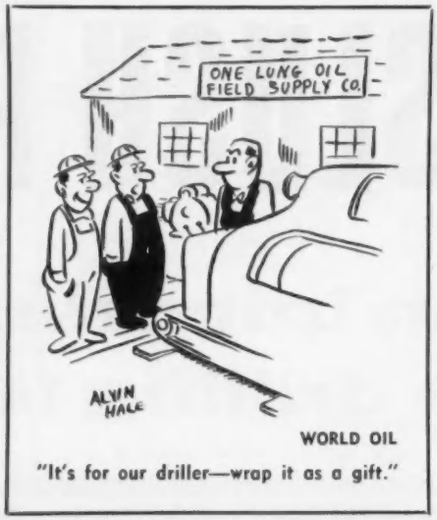

WORLD OIL

"It's for our driller—wrap it as a gift."

Texas and immediately asked her for a dance. Shortly afterwards his pal noticed that he was standing in the middle of the dance floor, looking completely bewildered, while the girl was walking angrily away. Going over to his friend he asked, "What happened? What did you do?"

"Nothing! I didn't do a thing," was the reply. "When she asked me where I came from, I put my finger on Amarillo, then she slapped me and walked off!"

What'll You Have

Many a man who goes into a bar for an eye-opener comes out blind.

It Was Thith Way

An editor received a story from one of his reporters about the theft of 2025 pigs from one farmer. Curious about the large number, he phoned the farmer. "Are you the farmer whose pigs were stolen?" he began.

"Yeth, I thure am," replied the farmer.

The editor thanked him, turned and rewrote the story about the theft of two sows and 25 pigs.

Nobody'll Ever Believe It

"How did you happen to hit the pedestrian?" the policeman asked.

"But I didn't hit him," declared the motorist. "I came to the stop sign and stopped. I motioned to him to go across, and he fainted!"

Latest Fashion

"Have you seen Ruth's new evening gown?"

"No, what does it look like?"

"Well, in most places it looks quite a lot like Ruth."

Conscience

That something which prompts a man to tell his wife before someone else does.

You Tell Me!

Guest phoning down from his hotel room: "Is this the desk clerk?"

Clerk: "Well, what's eating you now?"

Guest: "That's what I'd like to know."

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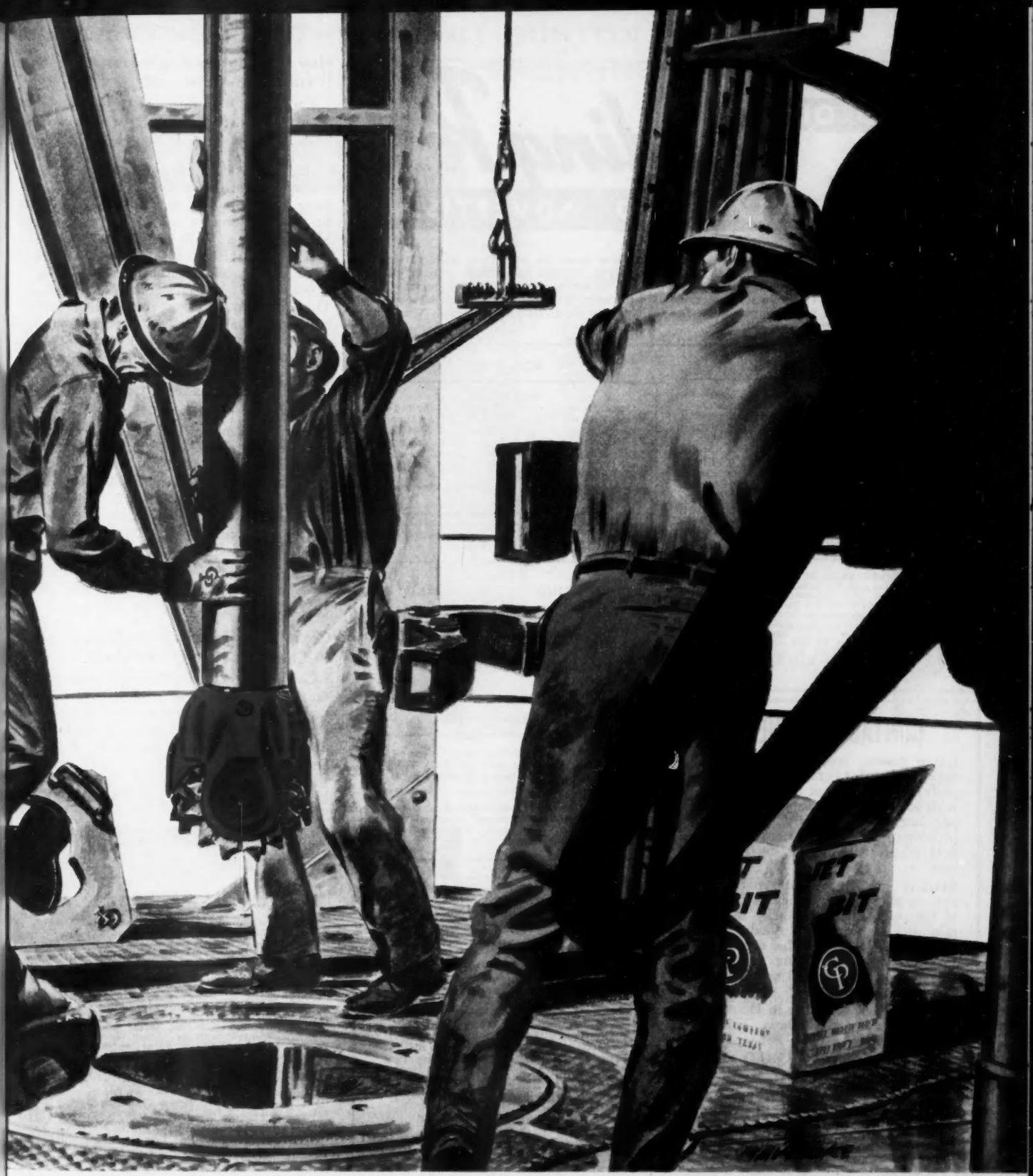

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SITUATIONS WANTED

■ PETROLEUM ECONOMIST, 30, Ph.D. Six years experience all phases oil industry economics, domestic and foreign. Will relocate in U. S., Canada. Box 142, WORLD OIL, Houston, Texas.

■ GEOLOGIST—Exceptionally well qualified with 11 years diversified experience to direct small company exploration and production program in the Southwest, particularly Texas. Box 141-W, WORLD OIL, Houston, Texas.

HELP WANTED

MECHANICAL ENGINEER—A leading manufacturer of Oilwell Drilling and Producing Equipment desires graduate engineers with experience in the design of Chain or Gear Driven Oilfield Pumping Units and their structural components to locate in the Mid-Continent Area. Salary commensurate with ability and experience. Replies should include resume of education and experience as well as salary requirements. Replies will be held in confidence. **B. C. Barron, Parkersburg Rig & Reel, P. O. Box 12007, Fort Worth 16, Texas**

CONTACT ENGINEER

Large eastern corporation has fine opportunity for graduate engineer preferably Petroleum or Mechanical with at least a few years oil field experience in drilling and production problems, similar experience in oil field supply activities or the equivalent.

Position involves liaison between eastern plants and oil field activities of the mid-continent, Rocky Mountain and California oil fields. Successful applicant will be given intensive product training at plant source and additional training in assignments.

Ultimate location either in Houston, Texas or Tulsa, Oklahoma. Tell us about yourself.

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MAJOR OIL COMPANY, Western North Carolina. (12 outlets: 2 owned & 10 lsed.) A HALF MILLION in sales! (Some retail accts.) Compl. eqpt. for all! Expan. oppty. & unlim. potential! Write 4 details & photo. Ref. 9019.

PETROLEUM JOBBER—S.W. MISS. Estab. '38. Carries franchise on Sinclair Products. Ask $33,330 plus inven. & accts receiv. On R.R. spur, loc. in lrge indus. commun. Eqpt & bldgs in gd cond. Write B-9515.

OIL WELL TORPEDO COMPANY—NW Tex. No compet. oil field area. Mfg sls nitro whlslrtel. Net $7,700. Ask $49,750 plant, 35 acres, 4 trucks, eqpt. Estab '19. Write 39574.

FUEL OIL-COAL COMPANY—NW Conn. Net $10,000 (incl. draw.) Val. prop w/300' RR siding incl. Ask $27,500. Write B42829.

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One Beaird-Ingersoll-Rand Packaged Compressor Plant Type 8 JVG, Direct Connected, 4-Cycle, Single Stage Gas Compressor. This unit for practical purposes is in new condition. Complete specifications and price will be quoted to prospective purchaser.
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■ INCORPORATE in Nevada for oil and mining projects. Do business anywhere. Positively no liability of organizers and stockholders. Over 25 years experience. Financing assistance at no additional cost. Write for Resume. L. O. Goodman, L.L.B., Box 991, Globe, Arizona.

Well organized, well established oil-well drilling contractor desires the management and supervision of oil properties in West Texas, Central Texas, and New Mexico. Can provide complete handling of oil properties from acquisition to production. No properties too small, and none too large to handle. Inquiries from independents, groups, small or medium sized oil companies invited. Write, wire or call collect for further information.

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New Mine Safety Appliances Is Formed in Mexico City

Formation of Mine Safety Appliances de Mexico, S. A. de C. V., was announced by C. M. Donahue, president of the new firm.

Arch S. Abbey, Latin American sales manager of Mine Safety Appliances Company of Pittsburgh, the parent firm, will be general manager, with headquarters in Mexico City, at Calle Azahares 47, (Colonia Santa Maria Insurgentes) Mexico City. Offices, manufacturing facilities and a warehouse are being established there. The complete line of more than 3600 MSA safety products and process control instruments will be stocked and shipped from the warehouse.

G & H Towing Opens Offices To Serve Louisiana Coast

G & H Towing Company opened offices in New Orleans recently. This office will coordinate G & H tug services to the oil industry for tidelands and deep sea towing from ports along the Louisiana coast. It will also coordinate the company's services which are now available at Morgan City, La., and which will soon be available from near Venice, La., where docking facilities for the company are now under construction.

Continental-Emsco Opens Office In Chicago's Pure Oil Building

Continental-Emsco Company announced the opening of a new sales office in Chicago. Under the direction of Harry T. Haugh, the new sales office is located in the Pure Oil Building at 35 E. Wacker Drive.

Haugh, formerly a sales representative located in Salem, Ill., joined Continental-Emsco in 1951.

STATEMENT REQUIRED BY THE ACT OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, and JULY 2, 1946 (Title 39, United States Code, Section 233) SHOWING THE OWNERSHIP, MANAGEMENT, AND CIRCULATION OF WORLD OIL, published monthly at Houston, Texas, for October, 1957.

1. The names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Ray L. Dudley, 3371 Chevy Chase, Houston, Texas; Editorial Director, Warren L. Baker, 5324 Cherokee, Houston, Texas; Managing Editor, Wallace Fitzgerald, 1514 Hewitt Drive, Houston, Texas; Business Manager, Robert M. de Sombre, 4410 Ingersoll, Houston, Texas.

2. The owner is: The Gulf Publishing Company, Houston, Texas; June Wooden Bliss, Houston, Texas; June Wooden Dudley Bliss—Trustee, Houston, Texas; Mrs. Grace C. Carter, Dallas, Texas; Mrs. Margaret D. Cashman, Beaumont, Texas; Drum & Company, c/o Trust Department, Houston, Texas; P. Stinson Dudley, Eldorado, Texas, Ray L. Dudley, Houston, Texas; William G. Dudley, Houston, Texas; William V. Gross, Alpine, Texas; Mrs. Carolyn Dodson Keeble, Abilene, Texas; Mrs. Anita S. Lane, Houston, Texas; Charles H. Lane, Houston, Texas; James William Nelson, Baytown, Texas; Tom W. Nelson, Houston, Texas; Mrs. Sallie Windham Ridley, Houston, Texas; Walter Gage Sterling—Trustee, Houston, Texas; O. R. Waller, Chicago, Illinois.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities are: NONE.

4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

5. The average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the 12 months preceding the date shown above was: (This information is required from daily, weekly, semiweekly, and triweekly newspapers only.)

R. M. de SOMBRE
Business Manager

Sworn to and subscribed before me this 18th day of September, 1957.

P. J. AUCOIN
(Seal) Notary Public in and for Harris County, Texas.
(My commission expires June 1, 1959.)

DEPEND ON THESE HALLIBURTON PRODUCTS FOR BETTER OIL WELL CEMENTING

HALLIBURTON CEMENTING TOOLS

FORMATION PACKER SHOE

... installed on the first joint of a string of casing offers many advantages. This shoe is used in all areas where conditions require casing to be set on top of the producing formation, because:

★ Packer Shoe packs off open hole below casing, protecting low-pressure formations from cement contamination during cementing.

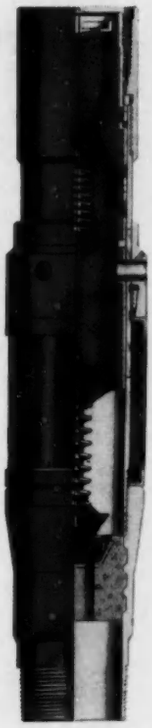
★ Packer Shoe floats in and guides casing to bottom.

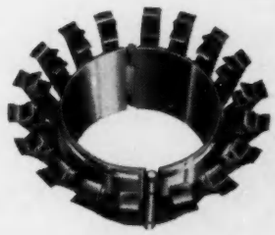
★ Packer Shoe has a Super-Seal Back-Pressure Valve to keep cement slurry from backing up inside the casing above the Formation Packer Shoe.

★ Packer Shoe provides circulation of fluids through end of Shoe until shoe packer rubber is expanded and set.

FORMATION PACKER COLLAR

... is installed on casing above the shoe joint to help protect a lower formation from contamination while cementing. Several joints of casing or liner may be installed on lower end of packer collar; the packer is set and cement pumped down casing and out into annulus above expanded packer. Used in setting liners, perforated pipe and screen in salt water disposal wells, water flooding projects and in fields where "Full Hole" cementing is desirable.





HALLIBURTON CEMENTING ADDITIVES

HI-DENSE

... is designed to increase the density of cement slurry for controlling high pressure gas and oil zones. Ground to a fineness that requires a minimum amount of mixing water. Because of the high specific gravity of Hi-Dense, it is possible to weight cement slurries to 20 lbs./gal., yet still maintain adequate pumpability and strength stability at high temperatures.

HA-5 CEMENT ACCELERATOR

.. an improved accelerator for oil well cementing slurries to be used for surface pipe or shallow wells. With HA-5 higher compressive strengths at early ages are obtained, thereby permitting a W. O. C. time as short as 4 hours on surface pipe where temperatures are approximately 80° F.

NEW RECIPO WALL CLEANER

... removes filter cake from wall of bore hole to allow better bonding of cement to formation and casing. The new Recipo Wall Cleaner offers these advantages:

★ Flexible, tough cleaning fingers minimize bore hole or filter cake damage while running casing, yet are sufficiently rugged to thoroughly clean wall when casing is reciprocated.

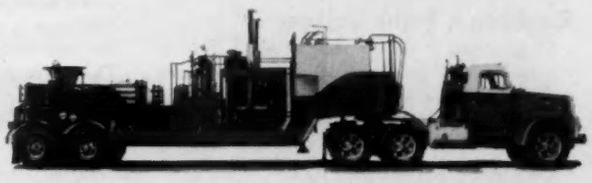
★ Wide cleaning fingers clean broader area of bore hole wall. Aid in breaking up channeling of cement.

★ Wide fluid passage areas between rubber cleaning fingers help reduce circulating pressures and bridging action of filter cake cuttings and lost circulation materials.

★ Hinged type design permits fast, easy installation on casing.

★ Cleaning fingers do not bend into permanent distortion.

CEMENTING SERVICES

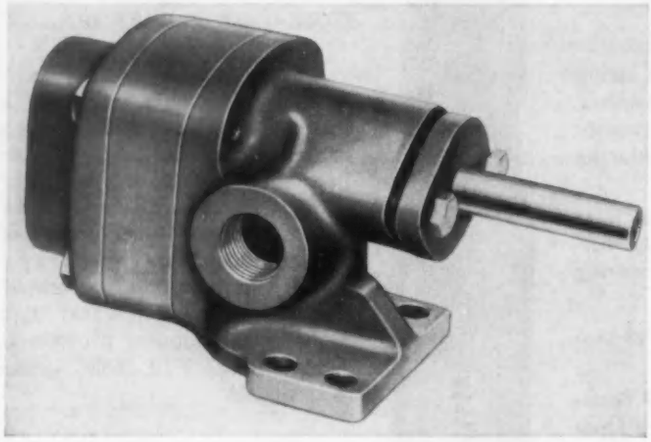


"A WELL WORTH CEMENTING IS WORTH CEMENTING WELL"

What's New in EQUIPMENT and SERVICES

Drilling - Production - Exploration

Heavy-Duty Rotary Pump



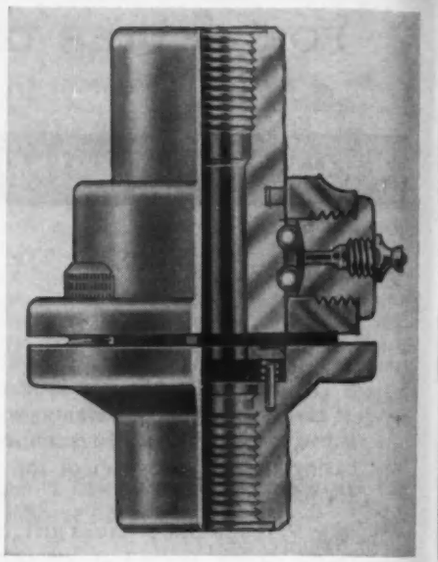
Worthington Corporation announces a new heavy-duty rotary pump line designed to meet the demand of industry for an efficient, economical, high-pressure pump. Available in sizes 1 through 4, the new herringbone gear rotary pump is applicable for oil burner service, high-pressure coolant service, small hydraulic systems, hydraulic lifts, filtration system, and circulation service and any other application requiring a low cost heavy duty pump for continuous service at pressures to 500 pounds per square inch in capacities to 25 gpm.

The new pump has suction and discharge openings from ½ inch N.P.T. to 1 inch N.P.T. and its simple, but rugged construction incorporates few operating parts for trouble-free service with minimum maintenance.

Outstanding features of the new pump include nodular iron herringbone gears, four force-feed lubricated roller bearings, replaceable steel-backed, bronze wear plates, and single stuffing box available with packing or mechanical seal for minimum leakage.

(This item supplements Worthington Corp., data on Pages 5597-5608 of the Composite Catalog, 22nd Edition.)

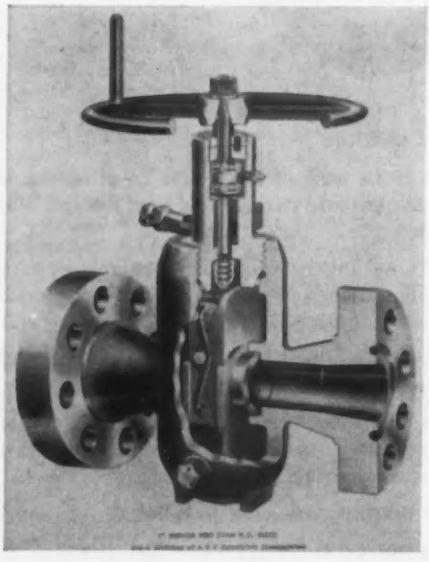
For more data, circle **No. E1** on Readers' Service Card, last page this issue.



pressure rating of 300 pounds per square inch. It is currently available in sizes of ⅜", ½", ¾" and 1".

(This item supplements Chiksan Co. data on Pages 1301-1320 of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E3** on Readers' Service Card, last page this issue.



Reduced Port Valve

Newest addition to the W-K-M line of valves for oil field services is a two-inch reduced port valve, specifically designed for use of christmas tree wing installations. As announced by W-K-M, a division of ACF Industries, Inc., the new valve is available in API working pressure of 5000 pounds per square inch.

It has the same basic features as have all the firm's through-conduit production valves including pressure seal bonnet, parallel expanding gates, two roller-thrust bearings, closed packing box and superfinished stem.

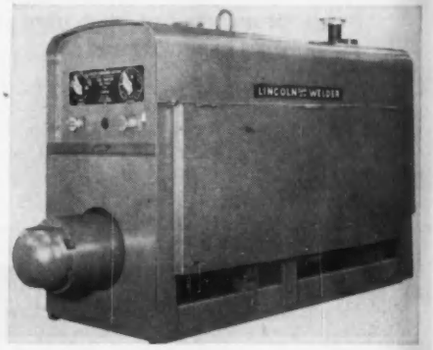
(This item supplements W-K-M Manufacturing Co., Inc., a subsidiary of ACF Industries, Inc., data on Pages 5257-5292-H of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E2** on Readers' Service Card, last page this issue.

Discpak Swivel Joint

A new swivel joint, designed specifically for steam and hot gas service, has been placed on the market by the Chiksan Company. Named the "Discpak," this new swivel packing units to be replaced without removing the "Discpak" from the line. The outer housing (female ball race portion) of the joint is cut apart at the packing chamber and both ends are flanged at the cut. This permits the joint to be parted at the packing chamber where the disc-type packing seal is located.

The new Discpak has a maximum temperature rating of 600°F. and a maximum



Gas Engine-Driven Welder

The Lincoln Electric Company announced a new model of its 6090, 200 ampere, gasoline engine-driven portable arc welder. The new welder, called the K-6090, is NEMA rated 200 amperes at 40 volts and 60 percent duty cycle, has dual controls for the generator output, an electrical outlet providing 1 kw of auxiliary DC power, an idling device, and is powered by a 36 horsepower water-cooled engine.

Controls on the new Model K-6090 include a five step selective current control and a continuous voltage control which also provides fine adjustments in the current. The ranges of the steps on the selective current control overlap, so that it is possible to obtain either a high or a low open circuit voltage for any current, thereby selecting the type of arc most appropriate for the work. The auxiliary power is 115 volt, DC, which may be used for power tools or lighting. Welding controls, auxiliary power outlet, and wing-nut output terminals for the welding cable are externally mounted and readily accessible.

For more data, circle **No. E4** on Readers' Service Card, last page this issue.

the laboratory of the oil industry

EIC develops tools for use in this laboratory.

At EIC, electronic and electromechanical development and manufacturing experience work for the industry.

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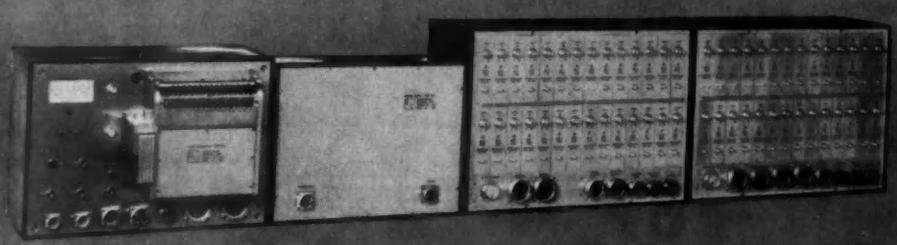
EIC's development experience and facilities are geared to geophysical and other oil industry problems.



ELECTRODYNAMIC INSTRUMENT CORPORATION

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Houston 5, Texas

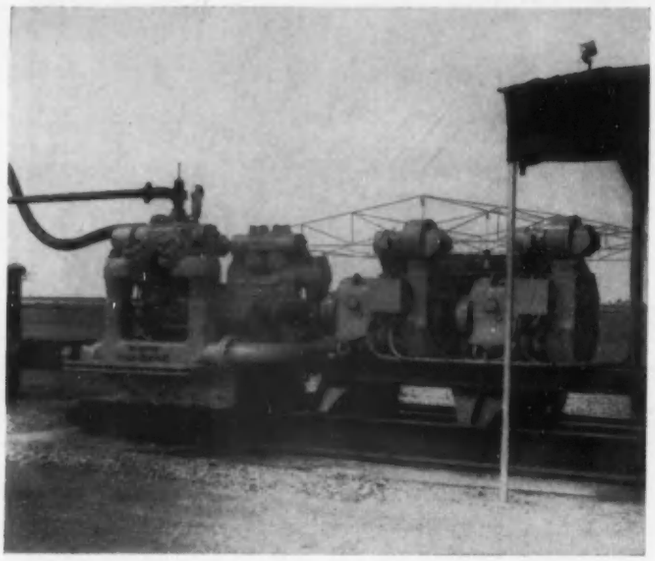


FIGURE 1—Over-all view of Cardwell's V-1500 mud pump.

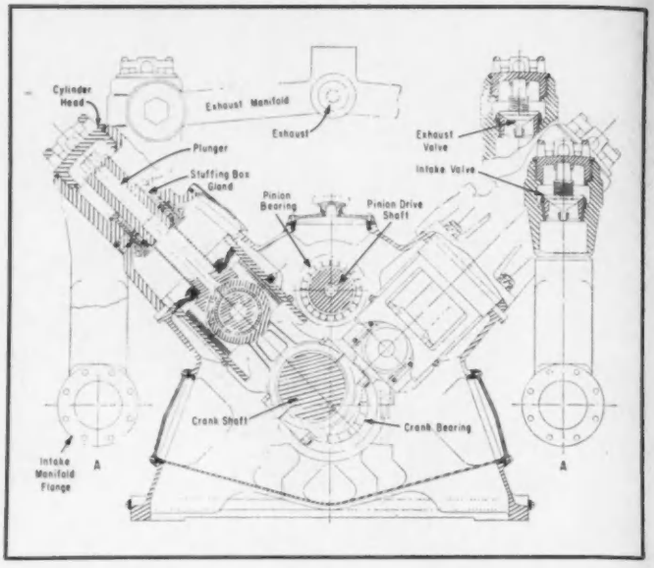


FIGURE 2—Cross-sectional view of V-1500 mud pump.

Cardwell Introduces New Quadruplex V-Type Slush Pump

Cardwell Manufacturing Company, Wichita, Kansas, has designed and developed a radically new V-type quadruplex slush pump (Figure 1). Weighing about one third the weight of the common duplex pump, this pump is rated at 1500 horsepower at 260 rpm. The over-all size of the pump is 7 feet by 7 feet by 7 feet and its weight is 23,000 pounds or 15⅓ pounds per hp.

Using plungers instead of pistons, this pump has an operating range of from 3500 to 2000 psi with volumes of 626 to 1114 gpm with six-inch, 5½-inch and 4½-inch plungers and an 8¾-inch stroke. Plunger sizes are easily interchanged. The fluid stuffing box can be installed as one unit. Preassembled complete packing units can be ready for installation at all times. A closed pressure lubrication system assures positive lubrication of all packing rings. The crank shaft is in two sections with support bearings on 13-inch centers. Two plungers are carried on each shaft. This eliminates the possibility of deflection and distortion from the plunger thrusts. Power input can be introduced at either or at both ends, and may be as is shown here, or the pump can be adapted to the conventional chain drive.

A cross-sectional view of the 1500 hp quadruplex showing the mud flow from intake to the plunger, then through discharge is shown in Figure 2. The manifold intake flanges on each side with the mud entrance to the plunger and the discharge is shown in the upper right. The threaded cylinder heads and the threaded packing units are also shown in this view.

Damaging pressure fluctuations in the discharge system are almost eliminated by the discharge frequency of the 1500 hp quadruplex pump. Figure 3 shows the flow variation through one complete revolution of both the conventional and quadruplex. The conventional duplex has the one extreme high, whereas the quadruplex has all highs the same in intensity. Fluctuations are not increased when the plunger sizes are changed as is the case with the conventional pump.

The performance chart for the 1500 hp quadruplex is shown in Table 1. As the plunger size decreases the pressure is increased with a corresponding decrease in the volume displaced, with the hp input remaining the same. The rated hp is based on 260 rpm, with operating volumetric efficiency of 100 percent and a mechanical efficiency of 85 percent. The rod load is 55,500 pounds.

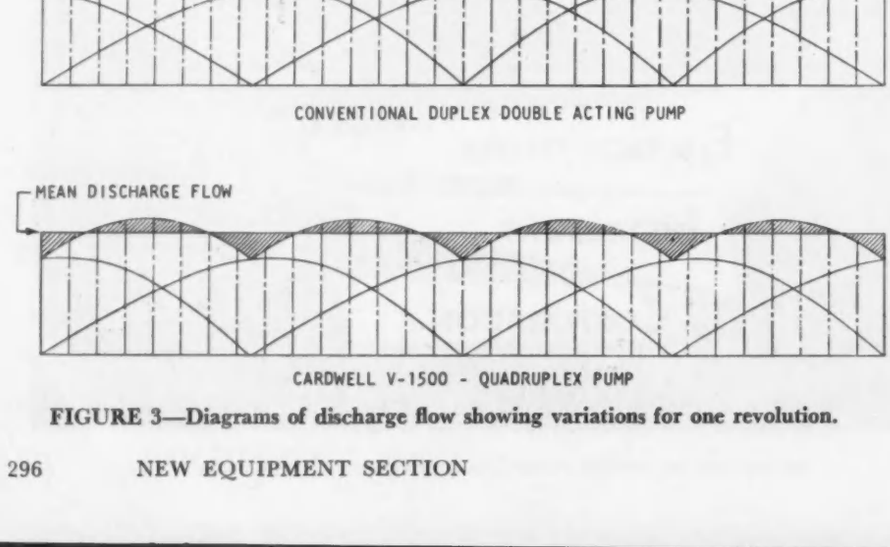


FIGURE 3—Diagrams of discharge flow showing variations for one revolution.

TABLE 1
Performance Chart for the 1500-HP Quadruplex

Pinion R.P.M.	Strokes Per Min.	Operating Data†	PLUNGER SIZE‡ 6″	5½″	5″	4½″
840	280	G.P.M.	1200	1008	833	635
		P.S.I.	1963	2336	2829	3494
		Input H.P.	1615	1615	1615	1615
780	260*	G.P.M.	1114	936	773	626
		P.S.I.	1963	2336	2829	3494
		Input H.P.	1500	1500	1500	1500
720	240	G.P.M.	1028	864	714	578
		P.S.I.	1963	2336	2829	3494
		Input H.P.	1384	1384	1384	1384
660	220	G.P.M.	943	792	655	530
		P.S.I.	1963	2336	2829	3494
		Input H.P.	1269	1269	1269	1269

* Rated H.P. Based on 260 S.P.M.
† Based on 100 Percent Volumetric Efficiency and 85 Percent Mechanical Efficiency.
‡ Rod Load 55,500 Lbs.

(This item supplements Cardwell Manufacturing Co. data on Pages 1213-1276 of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E5** on Readers' Service Card, last page this issue.

DRILLING

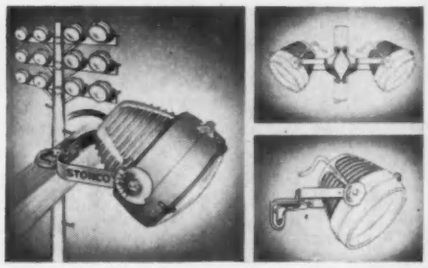
500-Ton Swivel

A new 500-ton swivel, the Tru-Line 500, has been announced by Ideco, Inc., one of the Dresser Industries. The Tru-Line 500 swivel, designed for the deepest, most severe drilling conditions yet encountered, utilizes four separate bearings for smooth, efficient, long-life operation.

The addition of a separate ball up-thrust bearing relieves the alignment bearings of any extra duties so that they maintain true alignment even during severe drilling conditions and when the swivel is put into the rathole. The two straight-roller alignment bearings are located at extreme ends of the swivel for maximum effectiveness.

(This item supplements IDECO, one of the Dresser Industries, data on Pages 2665-2732 of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E6** on Readers' Service Card, last page this issue.

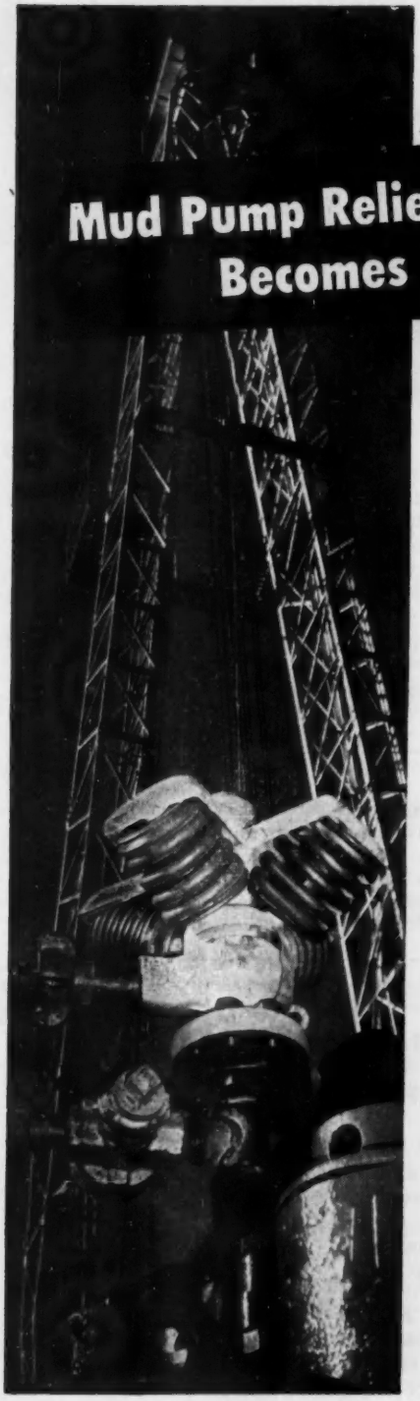


Powerbeam Floodlight

A new high powered floodlight designed for long-throw coverage of wide field areas has just been announced by Stonco Electric Products Company. Named the Powerbeam Sportslighter because of its particular adaptability to ball fields, driving ranges, stadiums and other open field areas, the new unit is smaller and much more compact than conventional floodlight types, and is reported to offer higher lighting levels with lower initial equipment and maintenance costs than is normally possible with floodlights operating with general service lamps.

The Sportslighter utilizes a 500-watt Powerbeam projector bulb sealed inside a heavy duty cast aluminum housing with a heavy plated steel trunion bracket that allows the unit to be swung over for safe, easy handling from behind. Degree-marked vertical and horizontal aiming quadrants permit pre-focus on the ground during daylight hours, while a repositioning stop automatically resets unit after servicing.

For more data, circle **No. E7** on Readers' Service Card, last page this issue.



Mud Pump Relief Valve Importance Becomes More Critical

As mud pumps are necessarily operated at near capacity to meet the constantly increasing demands on drilling circulating systems, the safety demands on the relief valve become greater.

Responsibility for reducing hazards of personal injury, equipment damage and drilling trouble by relief of excessive drilling mud pressures, calls for a valve that assures positive instantaneous pressure relief at maximum volume and automatic restoration of circulation upon correction of the overloading condition. These requirements have been accomplished in the Kinzbach Model 112 Pressure Relief Valve by combining two unique methods of restraining the valve piston, yielding a characteristic action from a decreasing force against the valve piston on opening movement, and conversely, an increasing force during closure. This assures higher effective lift during valve action.

When excessive circulating pressures occur, the valve either repeats its cycle of rapid opening and closing, or remains open until the obstruction is removed or the pump stopped. Momentary blocks do not require pump shutdown to reset the valve. Movement of fluid may not be materially affected, preventing dangor of stuck drill pipe as might occur with arrested circulation. Compounding Heads are available where pumps are used in series.

Kinzbach Model 112 Pressure Relief Valves are available in 2" and 3" sizes with pressures ranging from 500 psi to 16,500 psi. Write for complete data or consult your new Composite Catalog. Sold through Supply Stores everywhere.

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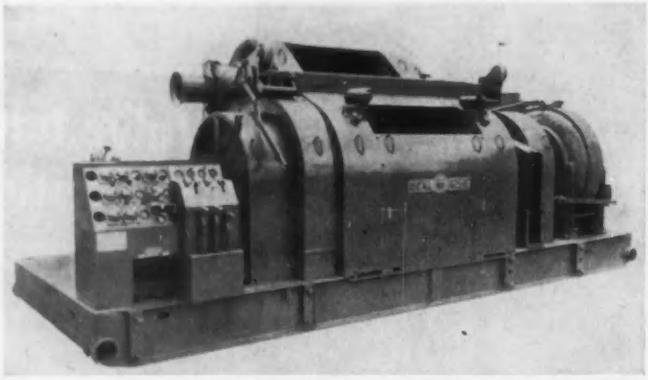
Electric Applied Drills



Development of the first of a series of drilling rigs intended primarily for electric application has been announced by The National Supply Company.

The new rig is in the class of National's biggest mechanically-powered rig, the Type 160, introduced in 1948, which in 1949 was the first to drill below 20,000 feet. Identified as the Type 1625DE, it will normally be considered for drilling in the 16,000 to 25,000-foot depth range, using 1⅜-inch or 1½-inch wire line, and utilizing from 1300 to 2000 horsepower delivered through electric motor drives.

The Type 1625DE drawworks is basically of one-piece design, on a heavy 18-inch beam base, and embodies provision for a sand reel. A rear section that accommodates the electric motors and the motor drive portion of the drawworks transmission may be detached for transportation purposes. The rotary may be driven by a countershaft, accommodated on a small, detachable front section of the drawworks base, or by an independent electric motor.

(This item supplements The National Supply Co. data on Pages 3641-3752 of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E8** on Readers' Service Card, last page this issue.

Grease and Oil Remover

Of major interest to all paint contractors, is the new surface cleaner just placed on the market by the Wilbur & Williams Company.

Every industrial paint application is always subject to the question of whether the surface has been properly cleaned to receive paint film. Now with the new W & W instant grease and oil remover Concentrate, applied to such a surface, it becomes self-insured against loss of adhesion, due to grease or oil on the surface.

This new Concentrate is built in such a way that one gallon of Concentrate, plus 31 gallons of water, is equivalent to 32 gallons of full strength cleaning compound which does not even have to be rinsed off before applying the first coat of paint.

The W & W instant grease and oil remover is particularly recommended for cleaning and degreasing of metals during manufacturing processes in continuous spray, tub, barrel or dipping operations and thus eliminates the danger of hot alkali dips currently being used.

For more data, circle **No. E9** on Readers' Service Card, last page this issue.

Truck-Mounted Drill

A new, diesel-powered, truck-mounted rotary drill that makes hole faster and lowers costs has been announced by Schramm, Inc. Costs are lowered because, under constant drilling operations, fuel consumption is reduced as much as 70 percent in comparison with units employing a compressor driven by the truck's gasoline engine. Savings are greatest for large quarry operators, water-well drillers and contractors who have available supplies of diesel fuel.

Field reports show that this unit, known as the Schramm truck-mounted, diesel-powered Rotadrill, makes hole 600 to 700 percent faster than is possible with the best churn drilling techniques.

The diesel engine, an International Harvester UD 1091, is direct-coupled to a

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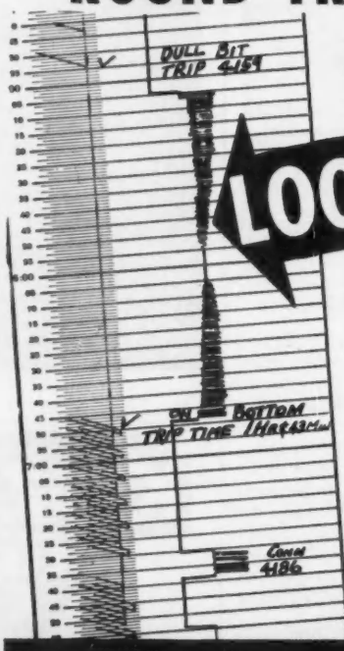

Round Trip Time stands out prominently on a Geolograph chart. The finished charts provide a permanent, duplicate record of tremendous value. Use a GEOLOGRAPH RECORDER the next time you drill or have a well drilled for you, it works for you 24 hours a day. Now available with "TRIP ACTION."

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right in the middle of it all

Why is CF&I Seamless Oil Country Casing and Tubing so popular in all of the oil and gas producing and exploration areas shown on this map? The answer's not just one thing but several. It's the way CF&I is centrally located so that superior service is assured . . . the way CF&I assures top-quality casing and tubing by operating one of the world's most modern seamless tube mills. Another big reason is that the men of the oil country know that CF&I is always trying to give them the materials and service they want.

CF&I Seamless Oil Country Casing and Tubing meets or exceeds API STD 5A specifications. It is available in 2-3/8" through 9-5/8" O.D.

CF&I SEAMLESS casing and tubing API

THE COLORADO FUEL AND IRON CORPORATION
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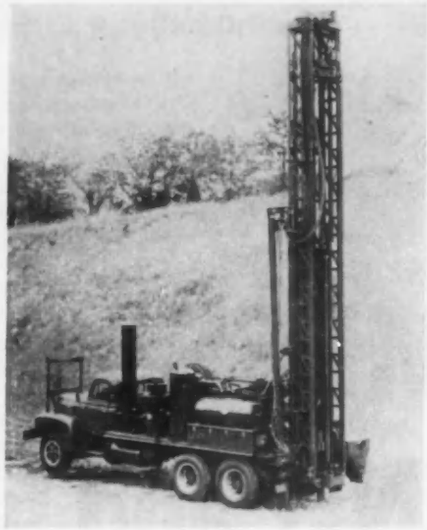
For more data on advertised products, use Readers' Service Cards, last page.



Schramm air compressor with no connection to the truck engine. Hydraulic pumps, the oil cooling system, and dust collecting fan are all driven by the diesel engine. Normally, the compressor delivers 450 cfm pounds per square inch. However, for dewatering or breaking out blockages, air pressure can be boosted to 200 pounds per square inch.

(This item supplements Schramm, Inc., data on Pages 4662-4663 of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E10** on Readers' Service Card, last page this issue.

PRODUCTION

B and W Clusters

B and W Clusters have shown improved primary cementing in good cement jobs in successful installations, where movement of casing was impractical. Included in the advantages are the following:

1. Sweeps and conditions as casing is run.
2. No movement of casing—during cement mixing and placement—is required.
3. As turbulence units, they prevent channelling, and provide effective cement seals at critical selected depths.

(This item supplements B and W Inc. data on Pages 381-388 of the Composite Catalog, 22nd Edition.)

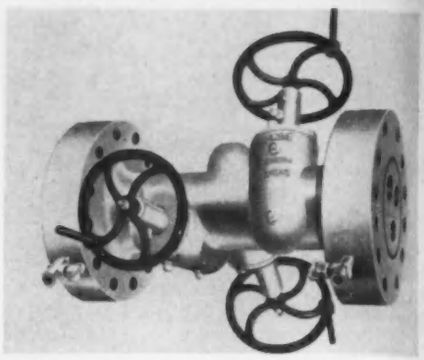
For more data, circle **No. E11** on Readers' Service Card, last page this issue.

Triple Valve

A triple valve with three two-inch through-conduit gate valves in a single body for use on triple completion christmas trees is now available from W-K-M, a division of ACF Industries, Inc.

The new valve is available in six models with API working pressures of 2000, 3000 and 5000 psi and eight and ten-inch flanges.

All parts are interchangeable with standard two-inch W-K-M production valves. The triple valve features pressure seal bonnets, two roller-thrust bearings, parallel expanding gates, closed packing boxes and superfinished stems.



(This item supplements W-K-M Manufacturing Co., Inc., a subsidiary of ACF Industries, Inc., data on Pages 5257-5292-H of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E12** on Readers' Service Card, last page this issue.

Tank Gage System

Completely new advances in automatic liquid level measurement are announced by Texas Instruments Incorporated with the introduction of the Data-Gage, first tank gaging system to combine unlimited-distance, error-safe telemetering, power float accuracy of ±1/16 inch, and 100-tank capacity.

The Data-Gage system consists of three compact and readily accessible units—

The VIKING
GEAR-WITHIN-A-GEAR
Rotary Pumping Principle

. . . operates equally well in either direction.

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Young 3-1-2
COOLING SYSTEM TREATMENT

Rust and Corrosion Inhibitor

Young 3-1-2 is a complete protective treatment for the cooling systems of diesel, gas and gasoline internal combustion engines. It prevents rust, controls scale, and protects aluminum, copper, ferrous metals, etc., from corrosion; and non-metals from deterioration.

Young 3-1-2 is furnished in pellet form, and since it is a *non-chromate* type treatment, it is non-irritating to the skin. No weighing or measuring is required: *3* pellets to *1* gallon of coolant, 2 times a year (under normal operating conditions) are recommended.

Young 3-1-2 will not deteriorate with age when stored in a dry area. It is compatible with all types of standard anti-freezes.

For further information write Dept. R977-L

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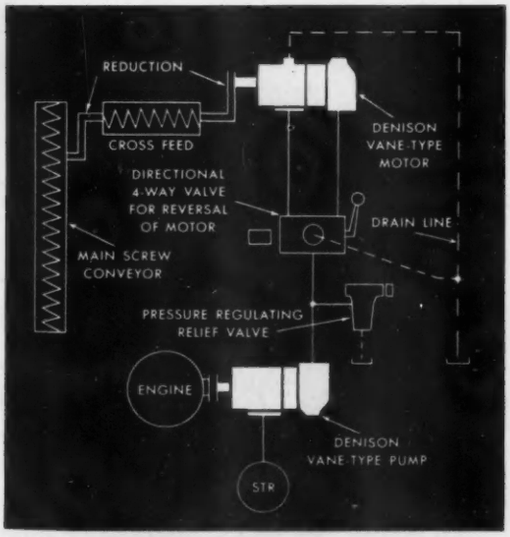
"Baroid Express" speeds mud handling

SPEEDY MUD HANDLING BEGINS when bags of Baroid are loaded into a "bazooka" mobile screw conveyor for fast loading to bulk delivery truck.

Photos courtesy Universal Baroid Corporation, Division of National Lead Company

DENISON hydraulic power keeps it on schedule



CIRCUIT DIAGRAM illustrates Denison 2000 psi hydraulic system for powering Louisiana Baroid's "bazooka" mobile screw conveyor.

Baroid . . . from bag to truck to drill site. Denison hydraulic power helps speed its delivery for fast, efficient mud handling.

To speed delivery of Baroid from bag to truck—Louisiana Baroid Sales Division counts on its hydraulic powered "bazooka" as a mobile conveyor. With this power feeder, bags of Baroid are simply emptied at waist height into an open hopper which cross-feeds to the main screw conveyor.

The heart of Louisiana Baroid's "bazooka" is a Denison 2000 psi hydraulic system consisting of a vane-type pump and interchangeable vane-type motor.

The vane pump—driven from a four-cylinder, 20-horsepower engine—supplies hydraulic power to the motor, which rotates the hopper screw and the main screw conveyor. The result is a simple but efficient variable-speed drive easily set to suit the needs of the operator.

This is another example of how Denison hydraulic power serves the petroleum industry. Remember, your Denison field representative is a hydraulic specialist who can suggest countless ways that you can benefit with Denison hydraulic power. Why not call him now?

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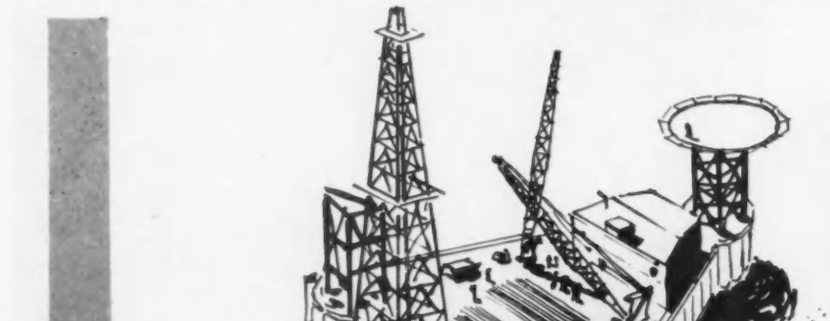
HYDRAULIC PRESSES • PUMPS • MOTORS • CONTROLS

receiver console, field selector unit and liquid level gage with power float.

The Receiver Console contains the instrumentation which initiates interrogation, decodes and checks the telemetered data, displays the correct data points, and supplies intelligence for printer, teletype, computer or other equipment as desired. Tank numerals, and depths from zero to 64 feet to the nearest 1/16 inch are displayed in columns on the inclined Data-Flash panel. Panel is black opaque with numerals invisible until illuminated from behind—then they become highly readable even in direct sunlight.

For more data, circle **No. E13** on Readers' Service Card, last page this issue.



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YOUR INSURANCE AGENT or broker knows the importance of experienced handling in arranging proper coverage, and he knows how much proper servicing of losses can mean to you. For this reason he will probably recommend placing the insurance on your offshore oil drilling and production equipment with a specialized market such as Southern Marine.

Important too, our Loss Prevention Service (included at no extra cost) is geared to work with you in preventing loss to (1) reduce future insurance costs and (2) prevent equipment down-time. Even with full reimbursement for loss or damage, equipment down-time for repairs knocks out your income. Ask those who use our Loss Prevention Service how well it works.

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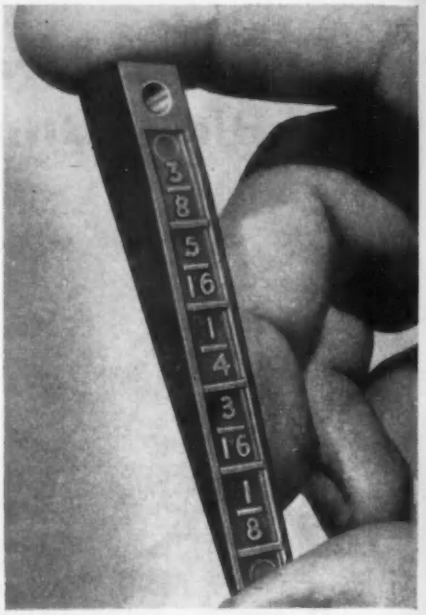


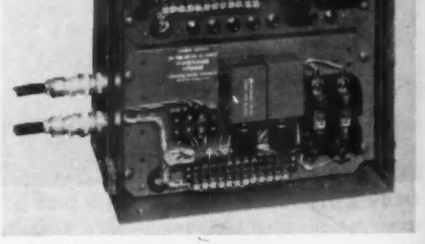
Sample Flange Gage

Check flange alignment accurately with this handy plastic flange gage distributed by Rector Well Equipment Company, Inc. This gage is precision moulded of colored plastic and calibrated from ⅛ inch to ⅜ inch.

By inserting the gage at intervals around the edge of the flange joint, you can quickly determine if flange faces are lined up evenly while the flange bolts are being tightened.

(This item supplements Rector Well Equipment Co., Inc., data on Pages 4401-4432 of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E14** on Readers' Service Card, last page this issue.



Automatic Flow Computer

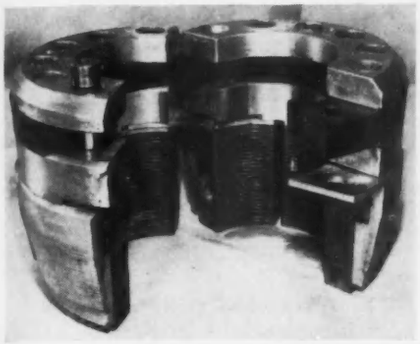
The SIE type DRF flow computer is a complete system, from transducer to printed record, for computing gas flow through an orifice. Using the AGA equation, all necessary corrections are introduced automatically, and results are visually indicated in analog or digital form.

Corrected flow from the DRF system

may be telemetered via telephone, wire lines or microwave and recorded on strip charts, log sheets, or punched cards. Both flow rate and integrated volume are instantaneously available for accounting, dispatching, automatic control and other applications.

The accuracy is 1 percent of full scale under all operating conditions, however, greater accuracy may be obtained over a limited range in environments normally encountered. Power requirement is 80 watts, 105-125 v AC 50-60 cps, single phase.

For more data, circle **No. E15** on Readers' Service Card, last page this issue.



Two Casing Hangers

Two new casing hangers, the Type C-8 automatic and Type RWA—both of the wrap around design—have been developed by the Petroleum Industry Equipment division of Alco Products, Inc. Outstanding features include strength and ease in handling and installation.

The C-8 automatic casing hanger supports the casing and effects a pressure seal utilizing the casing weight without additional bolts or set screws.

Basically, the hanger is of two-piece construction. One bolt on each side of the hanger are removed to open the hanger so that it can be placed around the pipe prior to dropping into the wellhead. This hanger consists of six segments of bowl section with a slip segment to each bowl segment. Contoured steps on the external surface of the bowl segments act as load carrying surfaces which prevent excessive reduction of the casing. Single straps at the joints in the hanger hold the hanger bowl and ring segments together.

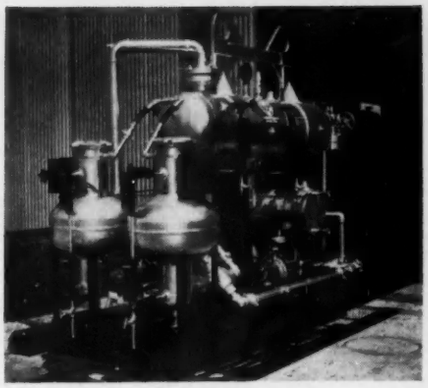
(This item supplements Alco Products Inc. data on Pages 149-168 of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E16** on Readers' Service Card, last page this issue.

Skid-Mounted Wellchecker

The problem of checking the production of offshore oil and gas wells has been solved by the Rolo Manufacturing Company with a new skid-mounted wellchecker specifically designed for marine work. The unit separates and meters oil, water and gas, operating through working pressure of 1200 pounds a square inch.

In addition to being advantageous in checking production of new wells, the portable wellchecker can easily be installed to analyze established producers.



The unit can easily be transported by service boat or barge to offshore installations. It is equipped with a special heavy duty lifting mechanism that facilitates movement from the barge to the platform.

(This item supplements Rolo Manufacturing Co., data on Pages 4564-4565 of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E17** on Readers' Service Card, last page this issue.

Geared Threader

Using special aluminum alloy castings, the Beaver No. 41-E geared threader has been reduced in weight by about 40 percent—making it the lightest 2½-inch to

swab cups "all alike"?

NOT ON YOUR LIFE!

There's a big difference in cups
Look at these Double-E features:

TYPE K — Medium & Heavy Loads
"Umbrella" top protects without restricting rib movement. Wire ribs embedded in *nylon*-reinforced rubber gives cups tremendous lifting capacity; longest life! Flexibility of unrestricted ribs permits lifting light or heavy loads *with the same cup!*

TYPE DK — Light & Medium Loads
(Also for sand-loaded fluids)
Cups really do the job and are safer in sandy fluids! *Controlled* expansion of cup under pressure means full recovery of fluid; longer cup wear. Rubber cup expands from within like a balloon. Seals positively. Correct engineering insures efficient swabbing *AND* safe retrieving!

Just try Double-E cups . . .
you'll never switch again!

EQUIPMENT ENGINEERS, INC.
2039 Amelia St., Dallas 35, Texas • LAkeside 6-3873

CUT STUCK SAND LINES INSIDE TUBING

KINLEY SAND LINE CUTTER

M. M. Kinley Company, Licensees

ABILENE, TEXAS
Hudson-Eads, Inc. ..... OR 2-5331
BAY CITY, TEXAS
J. P. Graham ..... CI 5-4526
BEAUMONT, TEXAS
Assoc. Eng. & Eqpt., Inc. .... TE 5-7046, ZF 8-2023
CASPER, WYOMING
C. A. White 3-5264
GLENDIVE, MONTANA
C. A. White ..... EM 5-3833
HOBBS, NEW MEXICO
Horne Well Service Co. 3-5396
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Assoc. Eng. & Eqpt., Inc. ..... CA 5-1103
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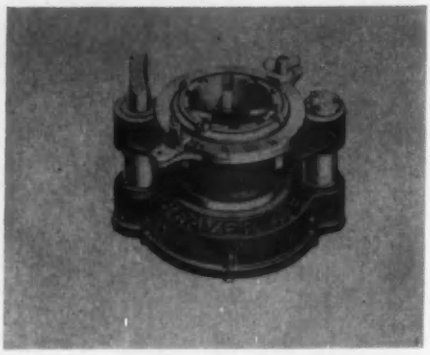
Davis-Kemp Tool Co., Inc. 5541
LAFAYETTE, LOUISIANA
Assoc. Eng. & Eqpt., Inc. ..... CE 5-6770
LIBERAL, KANSAS
Rainbo Service ..... Main 4-3598
LINDSAY, OKLAHOMA
Rainbo Service Co. 530
MIDLAND, TEXAS
Luccous Service & Eqpt. Co. ..... MU 2-1631
NEW ORLEANS, LOUISIANA
Assoc. Eng. & Eqpt., Inc. ..... VE 5-4983
OKLAHOMA CITY, OKLAHOMA
Rainbo Service Co. ..... ME 4-2131, ME 4-0105
WHITTIER, CALIFORNIA
Kline Wire Line Co. ..... OX 3-2731
WICHITA FALLS, TEXAS
Hudson-Eads, Inc. 2-3767, 2-8584, 3-4690



4-inch threader in the field. It is a fully adjustable threader for use by hand or with power drives, and its light weight makes it easier to use.

The Beaver 41-E uses only one set of dies for the full range of 2½-inch, 3-inch, 3½-inch and 4-inch. The die cam may be set to cut standard, deep or shallow threads of standard length. Both straight conduit and tapered threads can be made with the same set of dies by making a quick, simple adjustment.

(This item supplements Beaver Pipe Tools, Inc., data on Page 614 of the Composite Catalog, 21st Edition.)

For more data, circle **No. E18** on Readers' Service Card, last page this issue.

Quick Coupling Method

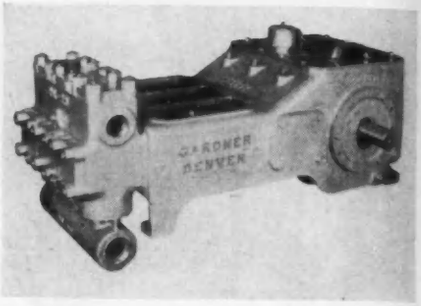
A new and economical method of quick coupling thin wall steel and aluminum pipe and tubing has just been introduced by the Victaulic Company of America.

Named "Vic-Easy" by the manufacturer, the new method provides positive, leak-tight connections through the use of quick couplings assembled on Vic-Easy grooved pipe ends. There is no loss of metal in the rolling and the pipe or tubing is as sound structurally as when manufactured.

The "Vic-Easy" Method is available for thin wall pipe and tubing in sizes from 1¼ inches to 12 inches, and may be used for working pressures up to 1000 pounds per square inch, depending on the wall thickness of the tubing and type of coupling used.

(This item supplements Victaulic Company of America data on Page 5254 of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E19** on Readers' Service Card, last page this issue.



Waterflood Pump

A new pump for waterflood and salt water disposal service is announced by Gardner-Denver Company, Quincy, Ill. There are now seven pumps in the line for this kind of service, the company's announcement points out, so that the right volume-pressure combination required by field conditions is readily available.

The new pump, called the PG-3, is a triplex plunger type, with maximum ratings in continuous service of 30 bhp, 500 bpd at 3050 psi and 1600 bpd at 940 psi. The weight of the PG-3 complete with aluminum-bronze fluid end is 1215 pounds.

(This item supplements Gardner-Denver Co. data on Pages 1945-1964 of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E20** on Readers' Service Card, last page this issue.

INCREASE PRODUCTION

CLEAN OUT CHOKING SAND

Excessive sand and sediment holds back your oil. For fast, easy clean out with fewer round trips and less downtime use world famous Miller Sand Pumps.

SAND PUMP SIZES

O.D.—2½, 3, 3½, 4¼, 5, 5½, 7 In.
Lengths—20, 25, 30 ft.

Composite Catalog, Page 3419

Write for descriptive price list

MILLER SAND PUMPS

Miller Sand Pump Co.

General Offices, Box 4516
Oklahoma City 9, Okla.

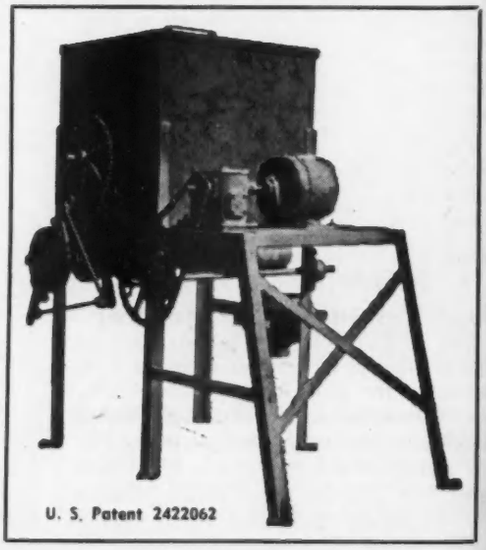
EXPORT OFFICES
30 Rockefeller Plaza
NEW YORK CITY 20, N. Y.

THE WESTERN CHEMICAL FEEDER

the dependable, economical water treater

CHECK THESE FEATURES:

- **Used in Oil Well Water Flooding, Municipal Water Treating Plants, Canneries, etc.**
- **Can be driven by water entering plant for treatment.**
- **Maintains pre-set water-chemical ratio through a wide rate-of-flow range.**
- **Adjustable two ways, to feed from a few pounds to several hundred pounds of chemicals per day.**
- **Also can be equipped with electric motor, or gas engine drive.**
- **Made to your specifications in various sizes.**
- **In use the world over.**



U. S. Patent 2422062

Whatever your water treating problems may be, investigate the Western Feeder. Write for literature and prices.

For complete description see Page 2843 of the Composite Catalog.

Manufactured By

KEYSTONE SUPPLY CO.

312 E. Cherokee St. Phone LD-10
NOWATA, OKLA.

New Equipment Catalogs and Literature

For more data on New Equipment or copies of Catalogs and Literature reviewed in this issue, use the Reader's Service postcards just inside the back cover and facing the Advertisers Index. Simply circle code numbers of items desired—sign and mail card. Requests are transmitted to the manufacturer as soon as received by us for mailing of desired information directly to you.

Washover Shoe Data

A four-page folder showing airbrush drawings of flat types and conventional types of rotary washover shoes utilizing Itcoloy tungsten sintered carbide is now available from the manufacturer. Manufactured in a complete line, ten variants or combinations are pictured. General data on special Itcoloy alloy sintered carbide as applied and forms available are also shown.

To get a copy, circle **No. E21** on Readers' Service Card, last page this issue.

Valve Chart

A new 19 by 24-inch, three-color chart containing maintenance and lubrication information for Rockwell-Nordstrom lubricated plug valves has been issued by Rockwell Manufacturing Company. Made of heavy paper and equipped with metal edges, the chart is suitable for display on shop, engineering and maintenance office walls.

It features detailed exploded views of four types of Rockwell-Nordstrom valves—two-bolt cover, screwed gland, three-bolt and Hypreseal. Also included is a table of recommended lubricants for oil, water, gas and chemical service, as well as complete instructions covering valve servicing.

To get a copy, circle **No. E22** on Readers' Service Card, last page this issue.

Footage Folder

"Jet Bit Drilling Hydraulics" presents a series of easily read two-color graphs and charts that will solve the flow resistance problems most commonly encountered with jet bits. In addition a number of perforated computation forms are bound into the book to simplify calculations.

To get a copy, circle **No. E23** on Readers' Service Card, last page this issue.

Water Flood Product Data

Fludex, a new water flood and water disposal stimulator is fully described in an illustrated brochure recently issued by its manufacturer, the Tretolite Company. Since one of the problems in water flood operations is the incompatability of certain treating agents often needed to correct simultaneous problems, this literature gives full recognition to the need for a multi-purpose injectivity stimulator—and also gives a detailed description of just what Fludex is and how it works.

In addition to being a wetting agent which will condition the surfaces of the formation and permit faster and easier injection of water at lower operating pressures, Fludex is also identified as an effective bacteriostatic agent for the control of sulfate-reducing organisms, as a corrosion inhibitor, and as a scale preventive.

To get a copy, circle **No. E24** on Readers' Service Card, last page this issue.

Air Compressor Booklets

Three new pieces of literature describing the entire line of Westinghouse unit type and Le Roi stationary air compressors have been issued. The compressors described in the literature range in size from ½ to 100 horsepower and include both single and two-stage units.

Features described in the two-color folders are lubrication systems, automatic protections, and volumes and pressures.

To get a copy, circle **No. E25** on Readers' Service Card, last page this issue.

Air Compressor Bulletin

An eight-page, two-color bulletin, P-106B, describing the new Le Roi 600 rotary air compressor has been issued by the manufacturer, the Le Roi Division, Westinghouse Air Brake Co.

Several pages are devoted to design and to the unit construction of the compressor, which allows individual cylinders to be removed, decreasing downtime on repairs and increasing maintenance accessibility.

To get a copy, circle **No. E26** on Readers' Service Card, last page this issue.

Electric Power Bulletin

How two horsepower can do the job of 160 hp for keeping truck radio batteries charges, is described and illustrated in D. W. Onan & Sons Inc.'s new "Mobile Installations" folder, Form F-111.

The well-illustrated, eight-page folder describes three Onan packaged power systems, each specifically engineered to provide dependable, low-cost electric power for all users of mobile communications equipment.

To get a copy, circle **No. E27** on Readers' Service Card, last page this issue.

Stress Rupture Brochure

Those associated with design and application of equipment involving the use of tubular products at elevated temperatures and pressures will be increased in the data contained in Bulletin TDC-153B, recently issued by the Tubular Products division of the Babcock & Wilcox Company. This four-page folder presents the stress rupture data on a number of tubing steels used in such services. The new card furnishes the results of stress rupture tests on 14 steels including carbon steel, several alloy steels and ten different stainless steels.

To get a copy, circle **No. E28** on Readers' Service Card, last page this issue.

Offshore Platform Brochure

A new 16-page illustrated brochure describes basic requirements for a proposed offshore platform which will operate in waters up to 600 feet—or six times deeper than presently possible.

A total of 11 photographs and drawings illustrate the brochure, which actually is a reproduction of a paper delivered September 24 by R. L. LeTourneau, vice president of R. G. LeTourneau, Inc., before the Petroleum division of the ASME at Tulsa. Title of the brochure is "Mobile and Fixed Platforms for Waters Up to 600 Feet."

To get a copy, circle **No. E29** on Readers' Service Card, last page this issue.

Sea-Crane Booklet

Offshore oil drillers and personnel responsible for supply of offshore rigs will be interested in a new Sea-Crane catalog being offered by Link-Belt Speeder Corporation, a subsidiary of Link-Belt Company.

The illustrated catalog covers a line of five pedestal-mounted lifting cranes that have been specially designed for mounting on tenders, lighters and other offshore supply craft. Called Sea-Cranes, these recently introduced machines are rated at from 12½ to 35-ton lifting capacities.

To get a copy, circle **No. E30** on Readers' Service Card, last page this issue.

Dowell Services Book

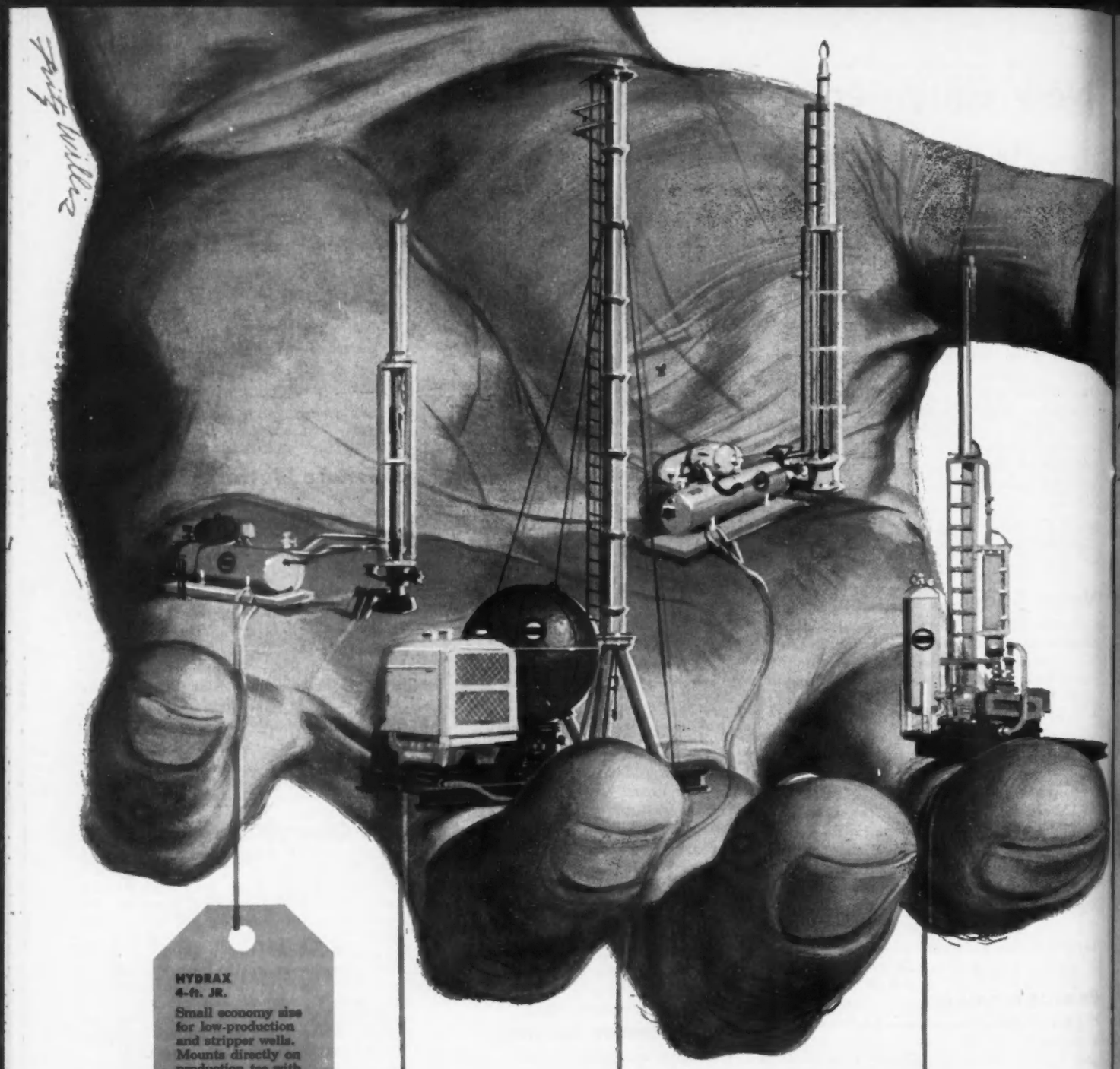
In this booklet Dowell Incorporated describes its services and products for increasing oil and gas production, increasing industrial plant through-put and improving the producing characteristics of wells by hydraulic or chemical-hydraulic means.

To get a copy, circle **No. E31** on Readers' Service Card, last page this issue.

Pumping Unit Manual

A new 20-page catalog on gear-driven pumping units has been issued by the Pumping Unit division of The Parkersburg Rig and Reel Company. Profusely illustrated, the booklet contains operating data and detailed mechanical and structural descriptions of Parkersburg pumping units.

To get a copy, circle **No. E32** on Readers' Service Card, last page this issue.



HYDRAX
4-ft. JR.

Small economy size for low-production and stripper wells. Mounts directly on production tee with no need for foundation or substructures. Polished rod capacity: 8,000 lb.

HYDRAX
LONG STROKE
COUNTERBALANCE

With 26½-foot strokes, the most effective in the industry, lifts up to 32,000 lb., can produce more barrels of oil per day than ever before possible. Many units have paid for themselves in six months.

HYDRAX
6-ft. and 10-ft.

Slow upstroke and fast downstroke provide ideal pumping cycle for yielding maximum crude from medium-production wells as deep as 8,500 feet. Polished rod capacity: 13,000 lb.

HYDRAX 10-ft.
COUNTERBALANCE

Can produce oil from a depth of a mile and a half, lifting 18,000 lb. a distance of 10 feet as many as 8 times per minute. Counterbalance provided by air pressure reduces horsepower requirement.

RAY L. DUDLEY 1891 – 1957

RAY L. DUDLEY, internationally known pioneer oil publisher, who headed the largest petroleum publishing house and the largest printing company in the southwest, died at his home in Houston on the afternoon of Tuesday, October 29.

President of Gulf Publishing Company, Mr. Dudley was the founder and publisher of WORLD OIL, PETROLEUM REFINER, and PIPE LINE INDUSTRY magazines, as well as Composite Catalogs for three branches of the oil industry. He also was chairman of the board of Gulf Printing Company.

His dynamic personality, zeal for accurate and forceful reporting, and burning desire to improve not only the publications but the oil industry in general—are reflected in the editorial character of the pages published under his direction over a full 40-year span, and will continue to be an inspiration to his organizations.

Mr. Dudley's enthusiasm and untiring energy must be given credit for the growth of the two companies into leading publishing and printing firms. He inspired and supervised this growth. It was with great satisfaction in his later years that he saw them firmly established with a future even more resplendent than he himself had yet witnessed.

From his earliest days as a newspaper reporter, Mr. Dudley displayed a fearlessness that distinguished his activity. He had his own thoughts on most questions and was outspoken with them. This characteristic, together with his personality and worldwide acquaintance in oil circles, made him a spokesman for the oil industry for many years.

His was a colorful, picturesque career, and it is easy for his associates and acquaintances to think of Ray Dudley as "an oil industry tradition" whose name will be linked with events and anecdotes about oil for years to come. Truly he created a place for himself and his publications.

Enthusiasm was another word for Ray Dudley. His heart, as his friends know, faltered on several occasions during the past decade and various other ailments slowed him down. But he never lost his desire to be up and about and doing things.

Looking ahead to the future, Mr. Dudley some years ago set up an Advisory Committee comprising other Gulf Publishing Company officials and department heads. He saw that this committee had a firm grasp on company affairs, so it would be prepared to carry on the activity of his beloved publications.

Ray Lofton Dudley, school teacher, newspaper reporter, editor, publisher, and business executive, was born in Denton County, Texas, August 8, 1891. His first oil industry connection came in 1916 with *Gulf Coast Oil News*. This periodical became *The Oil Weekly*, and then WORLD OIL in 1947. In 1922, Mr. Dudley founded PETROLEUM REFINER. Five years later, the Composite Catalog of Oil Field Equipment was started, and now is published in three volumes with more than 5000 pages. The Refinery Catalog appeared in 1933. In 1954, PIPE LINE INDUSTRY magazine was started for the pipe line branch of the petroleum industry. The Pipe Line Composite Catalog was issued for the first time in August, 1957.

Mr. Dudley was a past director of the American Petroleum Institute, a director of the Texas Mid-Continent Oil & Gas Association, and one of the founders and past president and national regent of NOMADS. In addition his list of civic activities was long and distinguished.

Mr. Dudley is survived by his wife, Frederica Gross Dudley; a son, William G. Dudley of Houston, and a daughter, Mrs. John E. Cashman of Beaumont. Two of the Dudley sons died in the service during World War II.

Funeral services were held at the Dudley home on October 31 and interment was in Houston.

What You Should Know About . . .

Federal Control of Natural Gas

Our federal government has taken a big new stride toward socialism. Since June of 1954, by Supreme Court decision, natural gas producers have been controlled by a government agency—the Federal Power Commission.

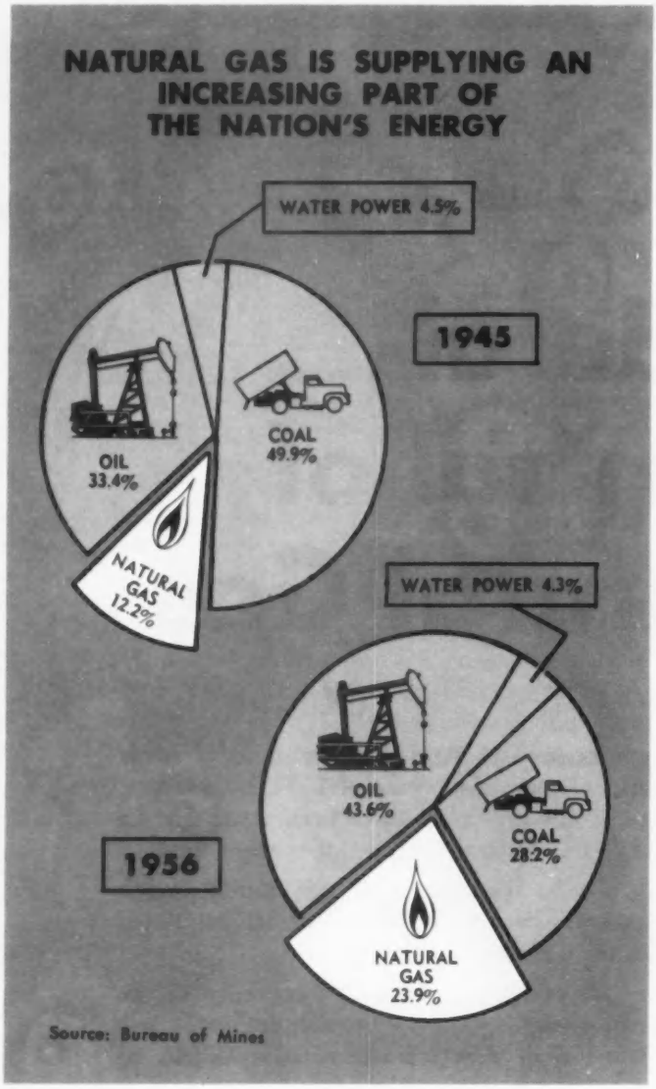
This is the first time in the history of our nation that a highly competitive industry has had its prices federally regulated at the point of production during times of peace.

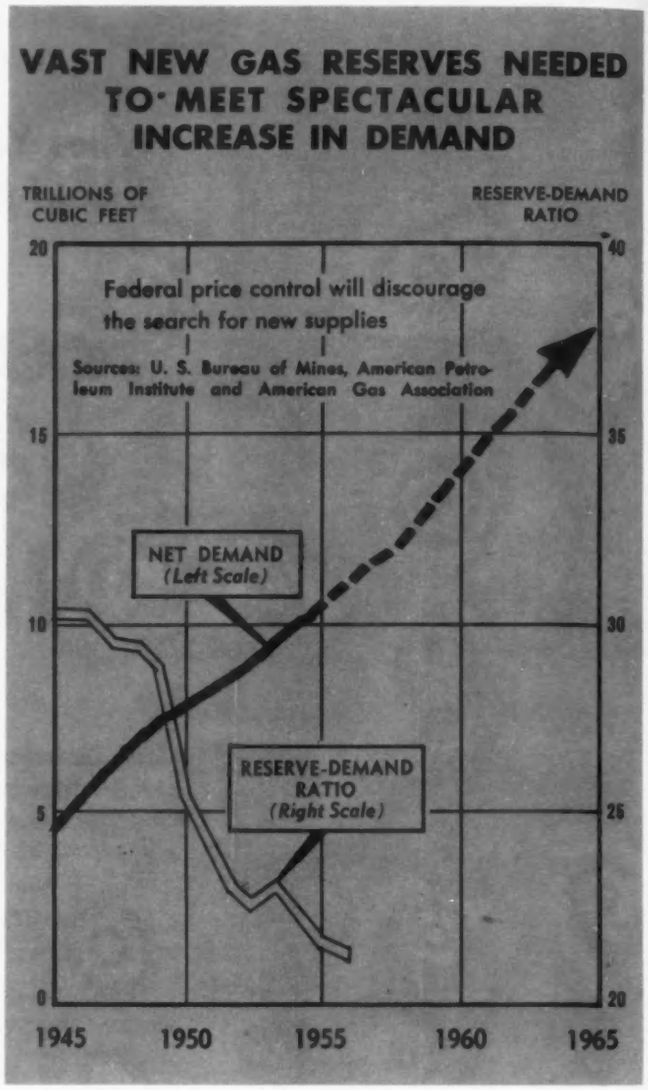
If this situation is allowed to continue, you not only will be without one of your basic rights—freedom to compete—you will lose in four more ways, each of which will eat deep into your pocketbook:

- U. S. natural gas supply will dwindle.
- Industry will move to gas areas.
- Gas prices will go up.
- Your tax burden will increase.

In the long run, the public will be the loser . . .

Supplement to the November, 1957 issues of
WORLD OIL and PIPE LINE INDUSTRY
By Don E. Lambert





Supply Will Dwindle

The demand for natural gas seems to be insatiable. While some 60 percent of the householders in the Southwestern producing states rely on natural gas, only 15 percent of the homes outside that area have been able to obtain it so far. A tally of major cities shows several hundred thousand householders on the waiting list.

Since 1945, demand for natural gas has doubled, while proved reserves increased by only one third. Demand is expected to continue rising at the same spectacular rate in coming years. By 1965, U. S. natural gas demand is expected to reach 17 trillion cubic feet annually, compared with 11 trillion cubic feet in 1956. Vast additional new gas supplies must be found to satisfy higher future demand. Yet, if federal control is allowed to continue the consumer can expect to have less gas available, not more. Why?

It is impossible to have a flexible and responsive fuel economy with oil and coal freely competitive, while gas producers' prices are fixed by regulation.

Presumably the purpose of the plan to fix the producer's price of gas is to establish it somewhere below that which would be established by competition.

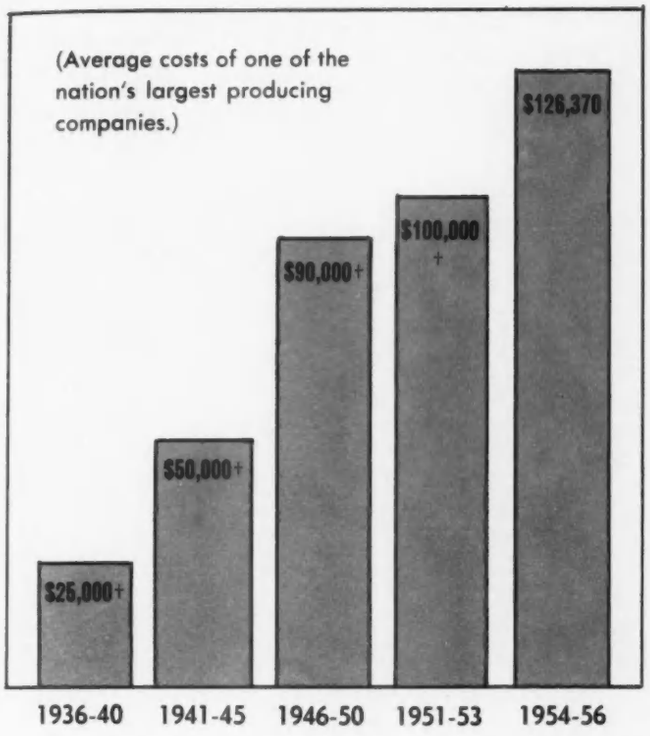
What are the effects of such regulated low price? It would tend to sharply increase the number of customers desiring to use gas. By the same token, it would tend to lower the demand for oil and coal.

However, the low price would lessen incentive to explore for and develop natural gas. There would not be enough gas to supply increasing demand. When a gas producer drills exploratory wells, industry experience tells him that, on the average, he will drill eight dry holes before he hits one that produces. Dry or not, many of these wells will cost him around $100,000 each, and some will range up to $1 million. Drilling costs have risen sharply (See chart, page 3), and now are five times larger than before World War II. Gas producers must receive sufficient prices to offset rising costs.

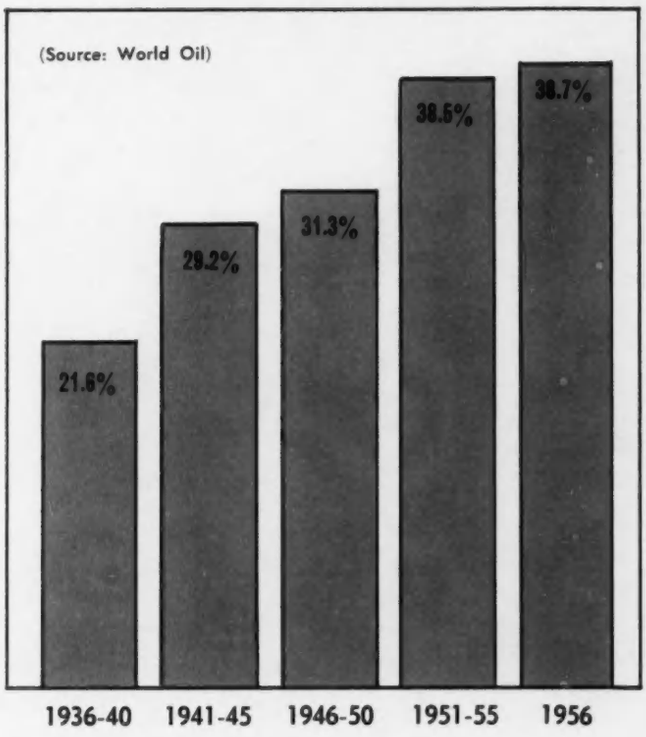
Subsequent production of underground reserves discovered by the successful exploratory well must of course compensate for exploration and drilling of the eight dry holes. But, when financial risks are great and rewards are limited by federal price fixing, the risks simply aren't worth taking—so the discovery and development of new gas supplies will inevitably be retarded.

In addition there will be a growing trend on the part of producers to sell their gas within the state where it is produced, so as to avoid price controls. Thus, supply

COST OF DRILLING AVERAGE WELL IS FIVE TIMES GREATER TODAY THAN PRE-WAR



IN ADDITION TO RISING COSTS, LARGER PROPORTION OF WELLS DRILLED ARE DRY



If adequate natural gas supplies are to be available to meet the nation's rising future needs, producers must receive a fair market price to offset the inflationary rise in labor and materials and larger dry hole losses.

to consumers in non-gas producing states will be further diminished.

With natural gas in short supply, the distributor will be forced either to prorate his deliveries to your home causing great inconvenience, or to cut off service entirely, forcing you to install new facilities and shift to coal or oil.

Thus, the primary interest of you, the consumer, is defeated. You will be deprived of a dependable supply of natural gas; and those of you who have been hoping, by extensions of service, to become gas customers will be doomed to frustration.

Prices Will Go Up

As was outlined above, under federal control the natural gas producers' efforts to find new reserves and to sell their product in interstate commerce will decrease. Supplies will dwindle. As demand increases, the consumer price can go nowhere but up!

Even so, the advocates of federal control often tell the gas customers it means lower prices.

Nothing could be farther from the truth. As the underground reserves now connected to interstate pipe lines are used up, and new supplies are not available, there is going to be that much less gas going through the lines and through distribution facilities to the consumer. Since the expense of transmission and distribution remains about the same even where less gas is involved, the individual consumer will have to shoulder the same amount of that total expense by paying a greater amount per unit of gas.

Under federal control, you will pay more for natural gas, not less.

You Will Have Other Cost Burdens

The cost you will have to bear under regulation is increasing in two additional dimensions:

Higher Tax Load. The budget of the Federal Power Commission has increased more than $1 million annually. The number of employes has increased from 624 in 1954 to 739 at present.

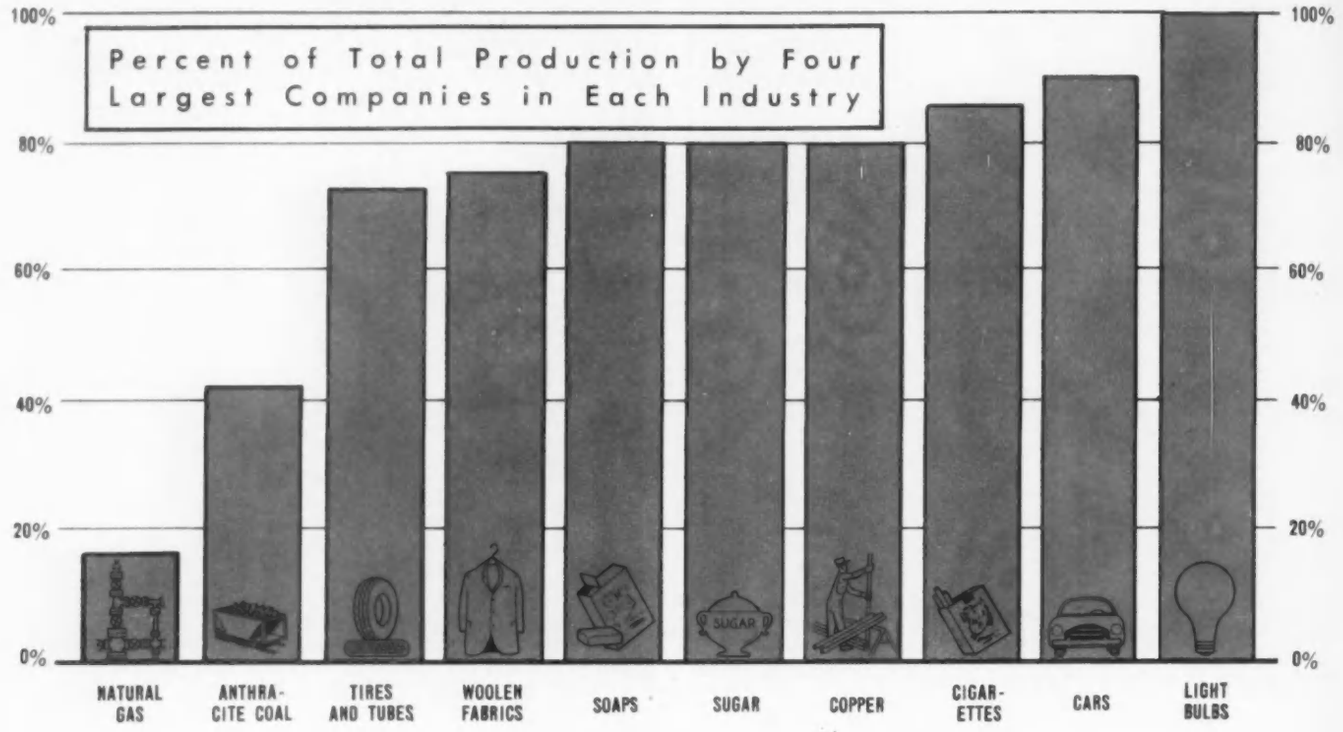
The Commission, in hearings on the 1958 budget, requested a further increase in the budget to $6,477,000 and 49 new positions. The House Committee on Appropriations denied this increase and held the budget at the 1957 level except for the retirement fund provision.

The cost of regulating must be paid from tax revenues.

Higher Operating Costs. The regulatory expense incurred by the companies, which is recognized and included in rate determination, is increasing to alarming proportions. Inquiry was made of six independent producers maintaining separate records of out-of-pocket cost incurred because of regulation. They reported their expenditures and their sales in interstate commerce for the year 1956.

Total additional expenditures because of regulation were $1,966,000 to handle sales in interstate commerce of 1.1 trillion cubic feet. Applying this rate to interstate

NATURAL GAS PRODUCERS ARE MUCH MORE COMPETITIVE THAN OTHER MAJOR INDUSTRIES



volume of approximately six trillion cubic feet in 1956, the estimated annual out-of-pocket cost of regulation to natural gas producers has already reached $11 million.

This is a high cost to saddle upon the consumer. And it is just the beginning. There is no recognition of executive time, office space, office personnel and supplies or overhead. If the present form of regulation continues, inevitably it will be necessary to provide separate offices, staffs and executives to handle regulatory matters.

You, the consumer, will have to pay the cost.

Industry May Re-Locate

Natural gas producers are not subject to federal price fixing if they sell within the state where it is produced. Instead, they are able to compete for a fair market price determined in an atmosphere of free competitive enterprise. They are not bogged down with the bulky and costly paper work that is required by the FPC.

As a result, natural gas producers are forced to take advantage of every opportunity to increase the sale of gas within the state where it is produced. Realizing this fact, a growing number of large industries are picking sites in gas producing states. They are protecting themselves against the danger of having to shut down a costly plant because of the producer's possible future inability to serve them.

The industry trend to gas producing states is clearly illustrated in the following statistics; Texas, Louisiana, Oklahoma, New Mexico and Kansas have 88 percent of the proved natural gas reserves, and produce more than 80 percent of the gas that is marketed in the U.S. These same five states on the average, already use 50 percent of the gas they produce within their own borders, completely outside the jurisdiction of the FPC. That leaves only half of the total supply to be distributed among the remaining 43 states. The competition is already keen, and if supplies dwindle, will become even greater.

To give another example, 27 years ago Texas marketed within its own borders only 25.7 percent of the natural gas it produced. The percentage was 52.1 in 1955. Also in Texas, one aluminum plant and one chemical factory together require as much gas as is supplied to all the homes in Detroit, Milwaukee and Kansas City combined.

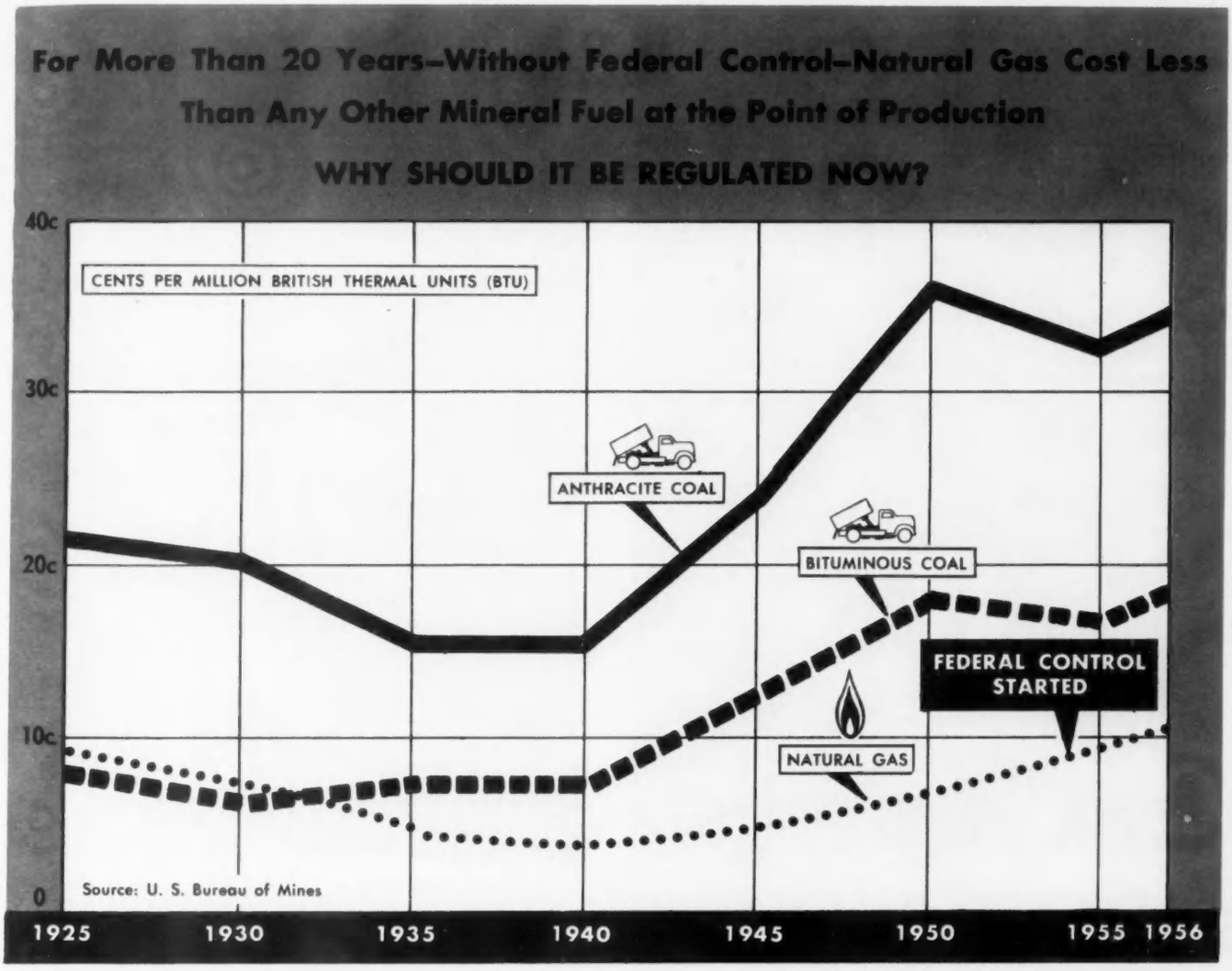
A vast, new and growing industrial empire has been built up in the Southwest where gas is plentiful at reasonable rates—lower than elsewhere because it does not cost as much to deliver it.

If you live in a non-gas producing area, the effects of this trend will be felt deep in your pocketbook. The economy of your area will suffer if industry is deprived of natural gas and is forced to convert to other more expensive fuels or move factories to the gas producing states. This would lead to the dislocation of many people, who would be forced to sell their homes and seek employment in gas producing states.

Natural Gas Is Just the Beginning

Natural gas production is no mysterious business operating by magic. It obeys the same economic laws as the businesses of producing all other commodities.

If the natural gas producer becomes subject to regu-



lation as though he were a public utility, and if he must sell his product at a price fixed by a federal regulatory agency, no producer of oil, or coal, or solid minerals, or cattle, or products of the soil, or steel, or automobiles, or manufactured supplies, or other commodities will be safe from similar price fixing.

Should federal control be allowed to continue, there would be nothing to stop a series of similar steps to control producers of other commodities. This is the first step toward socialism. And, as Churchill said, "Socialism did not abolish poverty in England—it only distributed it."

Socialism destroys—Freedom creates.

You will be the loser under federal control. It will pay you to take action to bring about an understanding of the problem and to secure corrective legislation. To accomplish this, you should know how the gas industry operates and why it should be left free to operate without federal regulation . . .

Three Distinct Divisions

Sometimes found alone, sometimes with oil, natural gas comes from underground reservoirs which are continually being depleted by heavy usage, so creating a continual demand for new discoveries.

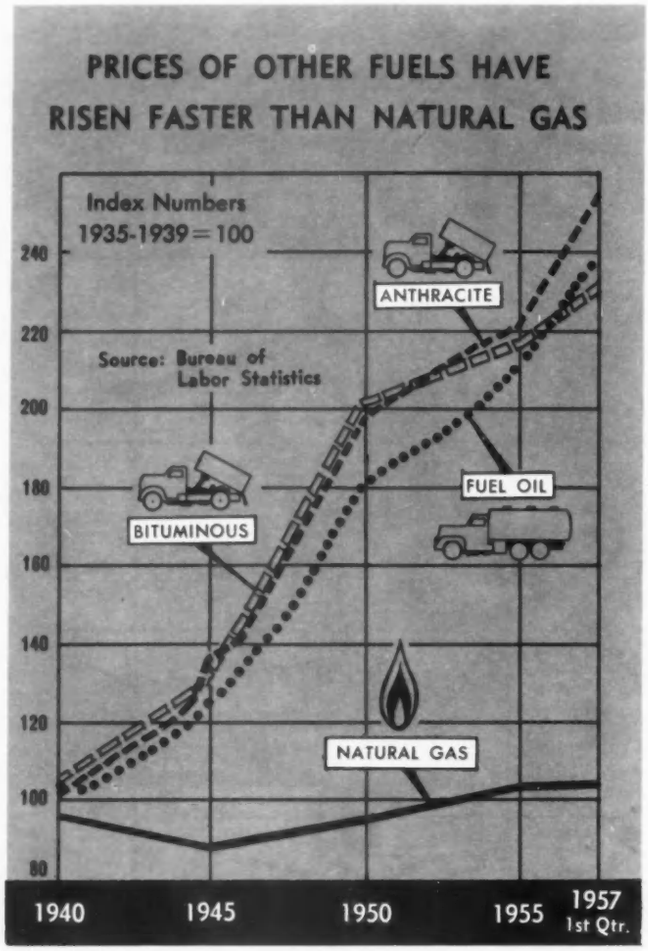
When the underground gas is brought to the surface, processing of various kinds takes place—including removal of natural gas liquids and oil. Some of the processed gas is held for local residential and industrial purposes. The balance is fed into pipe lines which may extend more than 1000 miles into non-producing areas, there to be distributed by local gas companies.

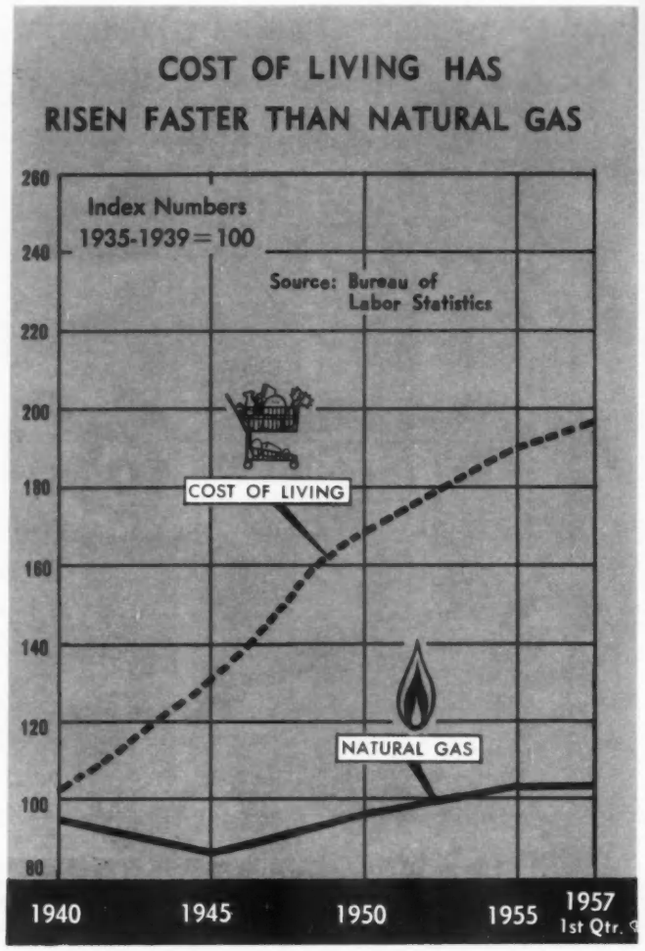
Usually, the job of getting gas from well to consumer falls to three separate groups: the producers who get it out of the ground, the pipe line operators who transport it to market, and the distributing companies who deliver it to the ultimate customer. Producer sells to pipe line, pipe line to distributor, and distributor to consumer.

Interstate pipe lines and distributing companies both have the characteristics of public utilities by nature and are regulated as such.

These two branches of the natural gas industry are granted franchises which authorize use of property to the exclusion of all others, and limits competition. As public utilities they enjoy another legal advantage—the right of eminent domain. By court order they can lay their lines across your property regardless of your views in the matter.

While their rates or charges for gas are regulated in exchange for the franchises they enjoy, the interstate pipe lines and city distributors are permitted to charge rates that are sufficient to provide a reasonable profit on their investment. Their risks, therefore, are greatly





reduced by elimination of competition and by assured profit. For example, the Federal Power Commission fixes the rates of interstate pipe lines so they will not exceed slightly over a 6 percent annual rate of return.

Producers Are Not Public Utilities

Here are the reasons . . .

1. The natural gas producer is given no exclusive area in which to develop natural gas supplies. He competes vigorously with all other producers seeking to find reserves.

2. He is not assured a geographically exclusive market for his output.

3. He is afforded no public license of a balance of supply and demand at a price that will afford him a fair return on investment.

4. There is no consistent relationship between capital investment and amount of production. The risk element of the oil and gas producing industry is well known to be exceptionally hazardous. Some make substantial capital outlays with little or no discovery. Others, with comparatively little expenditure, are fortunate enough to find sizable quantities.

Producers Are Highly Competitive

One of the major tests of a public utility is the amount of competition an industry, company or group of companies has. If there is little or no competition, federal regulation is adopted to protect the consumer.

No group is any more competitive than natural gas producers. The FPC estimates there are more than 5000 different operators producing gas in the United States.

Considering lease partnerships and those not selling in interstate markets, reliable sources place the total number of producers at 8000.

From an economic standpoint, the relative size of producers is more important than their number. The concentration of natural gas output is low compared with most large industries. The largest firm owns less than 10 percent of the domestic natural gas reserves. The four largest firms supply 17 percent of the *output*, the eight largest supply 28 percent, the 20 largest supply 46 percent, and the 50 largest supply 66 percent, and the remaining 34 percent is supplied by thousands of small producers. (See chart on page 4).

The concentration of national output is much higher in other mining industries, except for bituminous coal. In the Texas market, which is the largest and most important, the four largest producers supply about 21 percent of the output, the eight largest supply about 33 percent, and the

20 largest supply about 50 percent.

Natural gas producers are certainly not public utilities because of any lack of competition.

Competition Has Kept Prices Low

It is puzzling to understand why some groups are so anxious to see producer prices regulated. Producers receive only a small part of the consumers' total gas bill. Because of transportation and delivery expenses, consumer prices range from 70 cents per thousand cubic feet in gas producing areas to more than $2.00 per thousand cubic feet in areas far from producing fields. The average U. S. gas bill is about 89 cents per thousand cubic feet.

Only 10 to 15 percent of your total gas bill represents the cost of gas at the point of production.

Natural Gas Is the Cheapest. Official government indexes of wholesale and retail prices show a smaller relative increase for gas than for other fuels since 1945. During the past 10 years, the index of gas prices has increased at most about 20 percent, compared with gains of 50 to 80 percent for other fuels.

As of 1956, one million British thermal units (Btu) of energy sold at the point of production for an average of 10.1 cents in the case of natural gas, 18 cents for bituminous coal, 33 cents for anthracite coal. Even on new contracts, the average price for gas is less than for coal.

In the period from the passage of the Natural Gas Act in 1938 until 1954, during which there was no federal control of the field price of gas, the cost per million Btu's of heat content increased about 5 cents for natural gas compared with 12 cents for bituminous coal, 24 cents for anthracite coal, and about 30 cents for crude oil.

In short, the U. S. consumer pays less for the nation's cleanest, most efficient fuel than he would pay for coal or oil. However, this won't be true for long if producers lose their incentive to find and develop new reserves.

Needed: Legislation to Free Producers

There is no doubt that the federal price regulation imposed on natural gas producers would be disastrous to the industry, the consumer and the nation.

There is only one way to solve the problem: Corrective legislation.

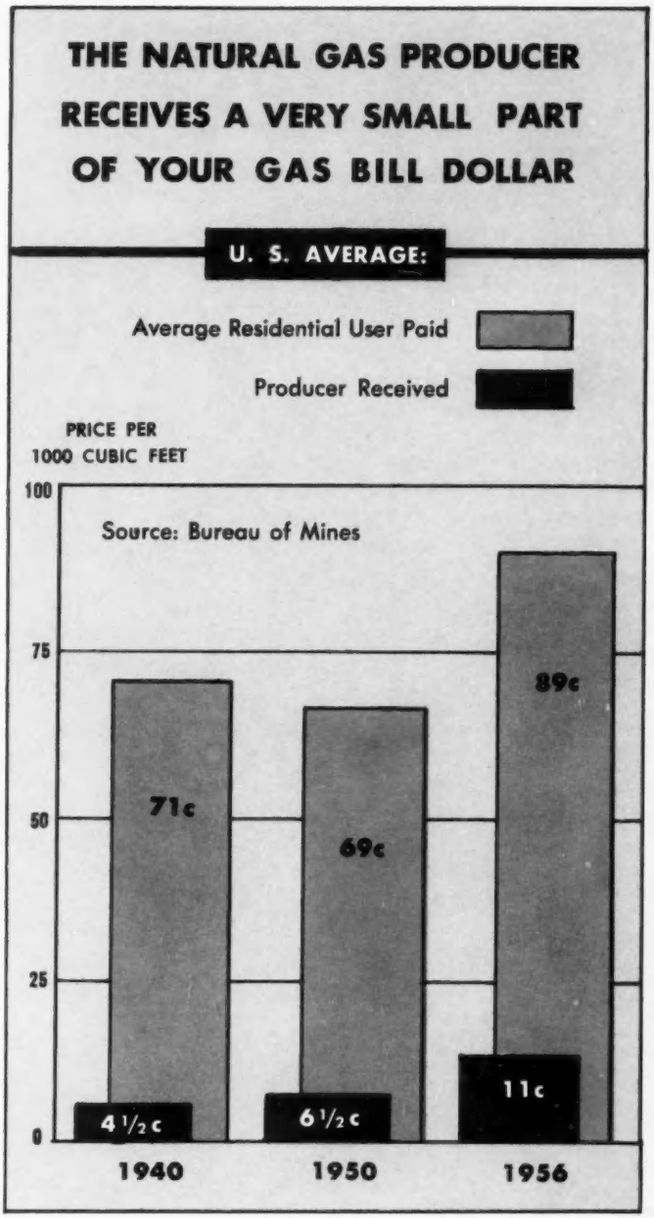
It has been clearly established that workable competition exists among producers of natural gas and is effective in determining fair prices at the point of production. Although prices of natural gas in the field have increased as a result of the economic forces affecting the market for fuels during the past 10 years, producer prices of other commodities have risen also—many much higher than natural gas (See chart, page 6).

Under these circumstances, competitively determined market prices should prevail for the good of our national economy. Any other level of prices, including federal control, will be artificial, and will create difficult problems of shortage that can easily be avoided.

The proper solution of the important natural gas problem is to rely on competitive market prices and to enact legislation designed to allow such market prices to prevail without regulation by government.

Although the Harris-O'Hara Bill will still allow federal control of market prices, it is the lesser of the two evils facing natural gas producers. The other evil is cost-plus control.

You can help the producers by giving active support to such legislation. By letting your senator and congressman know how you feel. To better equip you for such action, here is a brief review of the legislative activity that has transpired to date . . .



Case of Contradicting Interpretations

Congress in 1938 emphatically stated there was to be no federal control over natural gas producers. That year, our nation's legislators passed the Natural Gas Act which gave the FPC regulatory authority over transportation of natural gas in interstate commerce and over sales of gas in interstate commerce for resale.

But, Section 1 (b), the jurisdictional section of the Act, specifically says: "The provisions of this Act . . . shall not apply . . . to the production or gathering of natural gas." This section together with the legislative history of the

Act, evidences the intent of Congress not to regulate independent producers and gatherers.

In 1950, Congress passed the Kerr bill to establish once and for all that production was exempt from the Natural Gas Act. President Truman vetoed the bill.

The FPC itself ruled on 11 separate occasions between 1938 and 1951 that it had no jurisdiction over sales of natural gas by independent producers and gatherers. The last decision of the Federal Power Commission was in the ill-fated Phillips case in 1951.

The "Ides of March". The Phillips Ruling was appealed and ultimately reversed by a 5-to-3 split decision of the Supreme Court of the United States. The date of that decision, June 7, 1954, was the "Ides of March" for natural gas producers. The Supreme Court had ruled that wholesale sales of natural gas destined for resale in interstate commerce are subject to federal control.

Justice Clark had this to say about the interpretation: "It leaves a mass of empty pipe, vacant processing plants and thousands of hollow wells with scarecrow derricks as monuments to this new extension of Federal Power."

The FPC Stepped In. Immediately after the Supreme Court decision, the Federal Power Commission issued an order, since twice amended, which laced the nation's natural gas producers in a strait jacket. Producers were ordered to file for certificates on all contracts involving sale to a pipe line engaged in interstate transportation; their prices, in effect, were frozen as of June 7; and no matter how their contracts might read, they were prohibited from making new deliveries to interstate pipe lines or discontinuing old ones without prior FPC approval and certification.

This, in more direct terms, is federal hamstringing of free competition.

Try, Try Again. In 1956 another attempt was made to free natural gas producers from federal control as a public utility. This time it was the Harris-Fulbright Bill. Congress passed the measure. President Eisenhower vetoed it for reasons based on extraneous circumstances apart from the merits of the bill. Even so, the President stated that legislation conforming to the basic objectives of the bill is needed because the existing type of regulation "will discourage individual initiative and incentive to explore for and develop new sources of gas."

A New Effort Is Being Made

In his last budget message, President Eisenhower called for legislation that will insure gas consumer protection, incentives for supply development, fair and competitive producer prices, ending of utility-type controls, plus encouragement of sales to interstate markets to the benefit of consumers, producers and the national interest.

Such legislation has been prepared. It is the Harris-O'Hara Bill. The measure would give the Federal Power Commission authority to control producers' prices for gas moving in interstate commerce under a "reasonable market price" formula that will insure consumers adequate supplies and fair prices. There will still be federal control —but not public utility-like control.

The bill was cleared by the House Rules Committee last July and is now ready for vote in the Senate and House of Representatives when the next session of Congress convenes in January. It is generally conceded that at last legislation has been prepared which will answer most, if not all, the objections raised against the previous measures.

The Budget Bureau says the Harris-O'Hara Bill "largely fulfills" the President's recommendations and that it agrees with five "consumer protection" amendments sought by the FPC. In turn, the FPC has endorsed it as "sound in principle".

While local distributors opposed the 1955-56 bill, they now favor the present legislation because their objections have been met. Representative Wolverton (R.,N.J.) led the fight against the 1955-56 bill. He "unequivically supports" the bill as it is now written, because it will encourage supplies and protect consumers.

However, there are still those who are working hard to increase the federal government's control over industry. You can help stop these efforts by letting your Senator and Congressman know how you feel on the subject.

If the bill does not pass you can rest assured that natural gas prices will be much higher, because supply will be much less under FPC control.

Socialism will take a big step toward becoming your new way of life—freedom will be moving out the other door. The American people must protect themselves against these ends.

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